(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE

140 NASSAU STREET, NEW YORK

J. S. BONSALL, Business Manager.
F. H. THOMPSON, Eastern Representative

R. V. WRIGHT, E. A. AVERILL, } Editors.

MARCH, 1909

Subscriptions.—$2.00 *a year for the United States and Canada;* $2.75 *a year to Foreign Countries embraced in the Universal Postal Union. Remit by Express Money Order, Draft or Post Office Order. Subscription for this paper will be received and copies kept for sale by the Post Office News Co., 217 Dearborn St., Chicago, Ill. Damrell & Upham, 283 Washington St., Boston, Mass. Philip Roeder, 307 North Fourth St., St. Louis, Mo. R. S. Davis & Co., 346 Fifth Ave., Pittsburg, Pa. Century News Co., 6 Third St., S. Minneapolis, Minn. W. Dawson & Sons, Ltd., Cannon St., Bream's Buildings, London, E. C., England.*

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of owcial changes, and additions of new equipment for the road or the shop, by purchase or construction.*

CONTENTS

IMPROVEMENT IN LOCOMOTIVE FIRE BOXES.

On page 106 of this issue is illustrated what we believe to be the most radical change in the construction of locomotive fire-boxes that has ever been suggested, outside of a water tube equipment. Anything which will improve the steam-making capacity, decrease the cost of maintenance and increase the safety of a locomotive boiler is to be welcomed and it is with these three features in mind, accompanied by a desire for other less important improvements, that this design has been made. The matter of cost and rapidity of manufacture and renewal has been given careful attention and the different sections are all formed by dies and drilled from templets, so that they are exactly interchangeable in every way. This work is being done so accurately that when a complete fire-box is temporarily bolted in place a line of sight can be taken through any of the rivet holes throughout the length of the box, either inside or out, and the use of drift pins or forcing in any way is not required. This makes it possible to quickly and cheaply renew any section which may fail for any reason and greatly decreases the cost of manufacture. The opportunity for using very thin sheets, with their greater flexibilty and increased conductivity, for the inside fire-box sheets is also an important one, and should greatly assist in reducing maintenance troubles and cost, as well as improving the steaming capacity.

Taken altogether this design is worthy of the most careful study and we shall be glad to receive and publish the opinions our readers may form of it. That the Santa Fe officers have confidence in it, is evident from the fact that it has been specified for use on the two articulated type passenger locomotives now building at the Baldwin Locomotive Works which will be the largest locomotives in the world. In addition to this it is also being applied to some Santa Fe type locomotives at Topeka.

OUR NEXT ISSUE.

Our April issue will be of a special nature and will be devoted largely to railroad shop practice and machine tools. During the past year or so, while business has been dull, the machine tool builders have given considerable attention to re-designing and improving their tools, and as the railroads will shortly be in the market for considerable equipment of this kind a special issue, of the above mentioned nature, will prove timely.

CORRESPONDENCE.

In view of the vitally important part which letter-writing plays in the scheme of modern business it is somewhat surprising that more attention is not given to the instruction and training of men, often officials as well as clerks, in the proper principles and rules for obtaining the best results. If it were possible to compute the amount of time which is practically wasted by high salaried men in wading through a long and rambling letter, which more often than not, does not contain the desired information, the result would no doubt be so striking as to cause immediate attention to this subject. The story of the wrecking boss Harrigan illustrates a principle which is too often forgotten, even in railroad offices.

In addition to the principles of writing letters, the handling of the mail, particularly in connection with general offices, is in a majority of cases capable of considerable improvement, and can often be made to show direct savings of surprising amounts. In reporting on this feature recently a committee of the Association of Transportation and Car Accounting Officers stated that by having the mail for each address assembled and consolidated at regular intervals during the day in the different general offices or departments a saving of over 40 per cent. in the number of pieces handled could be made and a saving of from 75 to 100 dollars per month for postage on U. S. mail could be attained at one office investigated.

Mention of this feature was also made in connection with the instructions to chief clerks incorporated in the article on the organization of the motive power department of the L. S. & M. S. Ry., published in the December number of this journal; the section referred to being on page 468.

(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE

140 NASSAU STREET, NEW YORK

J. S. BONSALL, Business Manager.
F. H. THOMPSON, Eastern Representative

R. V. WRIGHT, E. A. AVERILL, } Editors.

MARCH, 1909

Subscriptions.—$2.00 *a year for the United States and Canada;* $2.75 *a year to Foreign Countries embraced in the Universal Postal Union. Remit by Express Money Order, Draft or Post Office Order.*
Subscription for this paper will be received and copies kept for sale by the Post Office News Co., 217 Dearborn St., Chicago, Ill.
Damrell & Upham, 283 Washington St., Boston, Mass.
Philip Roeder, 307 North Fourth St., St. Louis, Mo.
R. S. Davis & Co., 346 Fifth Ave., Pittsburg, Pa.
Century News Co., 6 Third St., S. Minneapolis, Minn.
W. Dawson & Sons, Ltd., Cannon St., Bream's Buildings, London, E. C., England.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of owcial changes, and additions of new equipment for the road or the shop, by purchase or construction.*

CONTENTS

IMPROVEMENT IN LOCOMOTIVE FIRE BOXES.

On page 106 of this issue is illustrated what we believe to be the most radical change in the construction of locomotive fire-boxes that has ever been suggested, outside of a water tube equipment. Anything which will improve the steam-making capacity, decrease the cost of maintenance and increase the safety of a locomotive boiler is to be welcomed and it is with these three features in mind, accompanied by a desire for other less important improvements, that this design has been made. The matter of cost and rapidity of manufacture and renewal has been given careful attention and the different sections are all formed by dies and drilled from templets, so that they are exactly interchangeable in every way. This work is being done so accurately that when a complete fire-box is temporarily bolted in place a line of sight can be taken through any of the rivet holes throughout the length of the box, either inside or out, and the use of drift pins or forcing in any way is not required. This makes it possible to quickly and cheaply renew any section which may fail for any reason and greatly decreases the cost of manufacture. The opportunity for using very thin sheets, with their greater flexibilty and increased conductivity, for the inside fire-box sheets is also an important one, and should greatly assist in reducing maintenance troubles and cost, as well as improving the steaming capacity.

Taken altogether this design is worthy of the most careful study and we shall be glad to receive and publish the opinions our readers may form of it. That the Santa Fe officers have confidence in it, is evident from the fact that it has been specified for use on the two articulated type passenger locomotives now building at the Baldwin Locomotive Works which will be the largest locomotives in the world. In addition to this it is also being applied to some Santa Fe type locomotives at Topeka.

OUR NEXT ISSUE.

Our April issue will be of a special nature and will be devoted largely to railroad shop practice and machine tools. During the past year or so, while business has been dull, the machine tool builders have given considerable attention to re-designing and improving their tools, and as the railroads will shortly be in the market for considerable equipment of this kind a special issue, of the above mentioned nature, will prove timely.

CORRESPONDENCE.

In view of the vitally important part which letter-writing plays in the scheme of modern business it is somewhat surprising that more attention is not given to the instruction and training of men, often officials as well as clerks, in the proper principles and rules for obtaining the best results. If it were possible to compute the amount of time which is practically wasted by high salaried men in wading through a long and rambling letter, which more often than not, does not contain the desired information, the result would no doubt be so striking as to cause immediate attention to this subject. The story of the wrecking boss Harrigan illustrates a principle which is too often forgotten, even in railroad offices.

In addition to the principles of writing letters, the handling of the mail, particularly in connection with general offices, is in a majority of cases capable of considerable improvement, and can often be made to show direct savings of surprising amounts. In reporting on this feature recently a committee of the Association of Transportation and Car Accounting Officers stated that by having the mail for each address assembled and consolidated at regular intervals during the day in the different general offices or departments a saving of over 40 per cent. in the number of pieces handled could be made and a saving of from 75 to 100 dollars per month for postage on U. S. mail could be attained at one office investigated.

Mention of this feature was also made in connection with the instructions to chief clerks incorporated in the article on the organization of the motive power department of the L. S. & M. S. Ry., published in the December number of this journal; the section referred to being on page 468.

THE RAILWAY BUSINESS ASSOCIATION—AN INSIDE VIEW

G. M. Basford.

For sixty days out of the one hundred and twenty days of the life of the Railway Business Association it has been the good fortune of the writer to be associated with this unique movement, and it is with regret that pressure of his own work makes it necessary for him to turn over to other hands the official duties of the position of secretary. A pleasant obligation will be fulfilled if some additional light may be thrown upon the accomplishments and possibilities of the work of the association from the inside.

It is doubtful if any association has ever before in such a brief period received such co-operation and recognition. Never before have the commercial interests dealing directly with the railroads been organized in such a way as this.

For very well understood reasons the railroads have not yet begun to share in the return of prosperity and while many commercial interests are busier than they were, those concerned in supplying railroads with material and equipment have been unable to secure orders sufficient to put their men back on full time. This serious situation brought together our members in an effort to effect a change in public opinion which would lead to an improvement of the general railroad situation and aid in restoring to prevent extremes in legislation constitutes a permanent

This movement was not only necessary but timely. The pendulum of popular sentiment had swung adversely to the railroads and swung too far, as indicated by a large amount of legislation, which affected the transportation interests by increasing the cost of railroad operation, while curtailing revenues.

At a recent dinner in New York the statement was made that during the years 1906 and 1907 the British Parliament enacted 114 laws for the government of Great Britain and Colonies, whereas during the same time Congress and the State Legislatures of the United States enacted 25,000 laws. It is reasonable to doubt that 12,000 wise laws, per year, can be enacted in any country. The thinking people who constitute the safeguard of the nation had begun to recognize that the railroad interests could not be adversely affected by restrictive legislation without affecting all other human interests. There has been no general sentiment in favor of weakening restriction of railroads, but there is a growing conviction that restriction must be intelligent.

The way in which the members of the association rallied to the call is scarcely more impressive than the ready support of the commercial public. By a combination of very important manufacturing concerns into a good-natured association, public opinion has crystallized to a gratifying extent and legislators, both State and National, have heard from the people in a voice devoid of quavering.

Some of the largest commercial associations have been ready and willing at the suggestion of the Association to make pacific utterances. Responses from the largest cities and from National Associations covering the entire country have been surprising. The voice asking for legislative quiet and for true statesmanship with respect to railroad enactments has come from many directions and from many interests, some of them being entirely separated from railroad affairs. Those, for instance, who make and sell shoes have co-operated through their national organizations to indicate appreciation of the fact that the welfare of those concerned in transportation is involved with their own welfare to such an extent as to justify a long step from their beaten paths to correct the unfortunate situation in which our members find themselves.

One reason for this co-operation lies in the recognition of the fact that the personnel of the association is remarkable in including men known for the most successful engineering, manufacturing, and commercial achievements. Some of our constituent concerns are as large commercially as a fairly large railroad. The number of men employed by such concerns as are represented in our membership is as great as the number employed by the railroads. Our association has conflicting competitive interests, all united in the bond of good fellowship to carry out the plan which makes for the common good. This plan is conducted absolutely independently of the railroads. It has been shown for the first time to be possible for influence outside of the railroads to band together to promote by organized action a realization of the inter-dependence between the public and the transportation interests.

Our activities are by this time very well known. In four months the fact has been demonstrated that the people are ready not only to acknowledge what the railroads have done for the country, but to give transportation questions the consideration which they deserve. To turn the light on obscure questions affecting the relation between the people and the railroads, tending to prevent extremes in legislation constitutes a permanent work for this organization.

Not all the work already accomplished has been easy. The railroads as well as the public have their part to do and the work of the association will include efforts to bring about a permanent friendly relationship. This cannot be done in a short time.

One of the most effective elements of the success of this association is the generous good fellowship of its members. The organization already extends into sixteen States and often competitive interests in the same city are united in local achievement. No discordant notes are heard in the conduct of its affairs and it is inconceivable that any will be heard under the leadership of such a personality as that of the president of the association, sustained by, and enjoying, the constant counsel of the able, energetic and potential men who compose its general executive committee. These two months in the executive office have been so crowded with important developments that they have seemed exceedingly short.

At the outset reasonable doubt of the possibilities of the movement may have been justified. Some may have felt that it was too intangible and experimental to win their instant support. Now there is no room for doubt. It is no longer experimental. The writer regrets that because of compelling business obligations he cannot continue in direct co-operation with a work so inspiring. This brief time has convinced him that the need for the organization was great, the field for its efforts wide, the plan of its work effective.

It is equally clear that so much remains to be done as to justify the question: How can any concern engaged in supplying the railroads with their requirements, delay enrollment in the Railway Business Association?

Fulton Bill Reported Adversely.—Senator Elkins in reporting the Fulton amendment adversely said: "The country is now demanding repose in its industrial upbuilding. It is not a time to experiment and to change the basis upon which the former acts to regulate commerce have been predicated. The recent law passed by Congress so greatly enlarging the authority of the commission should, before changes are sought, have the opportunity of at least a fair trial as to the value of its provisions in the regulation of interstate commerce. When trial has been given and normal conditions have been restored, any defect in the regulating statute can then, in the light of experience, be promptly passed."

JACOBS-SHUPERT LOCOMOTIVE FIRE BOX.

H. W. Jacobs.

Much effort and study have been expended upon the locomotive boiler to improve its efficiency in the generation of steam and to promote economy in its cost of maintenance. Many improvements have been made in its design and construction; yet no radical departure from early practice has been made since the locomotive reached its present general arrangement. Attempts at improvement have included a decided increase in size, a slight alteration of the general form, the occasional introduction of water tubes or the combustion chamber, and the widening of the water leg. The demand for greater tractive power has caused the enlargement of grate areas and the shape of firebox sheets and wrapper sheets has been modified. In the main, however, the principles long ago established have been adhered to until the present.

Long experience and careful study of the prevailing design, however, has led to the decision that improvements can be made in the arrangement and construction, and that the following results can be obtained:

1. The maximum of strength due to the form without artificial support, such as from stays.
2. A greater strength with a reduction in thickness and weight of material.
3. An increase of circulation of the water inside.
4. An increase in the circulation of the gases outside.
5. An increase of transference of heat from the gases to the water per unit of surface.
6. A reduction of weight in proportion to steaming power.
7. A greater heating surface in proportion to weight.
8. A reduction of fuel consumed per effective horse power.
9. A reduction of water delivered with the steam.
10. A reduction of heat delivered into the atmosphere.

The firebox meeting these requirements has been designed, and three are now under construction in Topeka shops of the Santa Fe Railroad. These boxes are being applied to what is known as the "Santa Fe type" engine, which is the largest engine in the world of rigid wheel-base design. This same type of firebox is also to be applied to the new passenger Mallet type engines, which will be the largest locomotives in the world of any type.

In this firebox the usual arrangement of flat sheets supported by staybolts has been abandoned except in the front sheets and door sheets. Side sheets and wrapper sheet have been replaced by sets of channel-shaped sections riveted together with their flanges away from the fire. Staybolts have been replaced by stay sheets, one at each joint of the channels, which are interposed between the sections and secured by the same rivets that

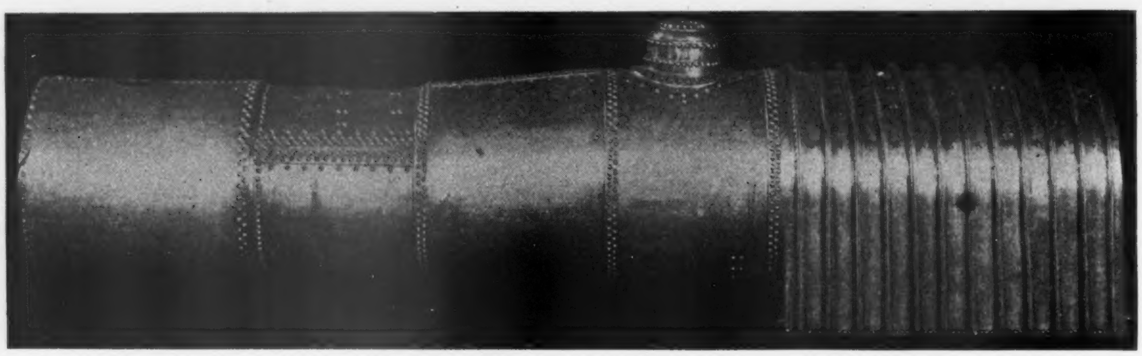


FIG. I.—VIEW OF COMPLETED BOILER WITH JACOBS-SCHUPERT FIREBOX.

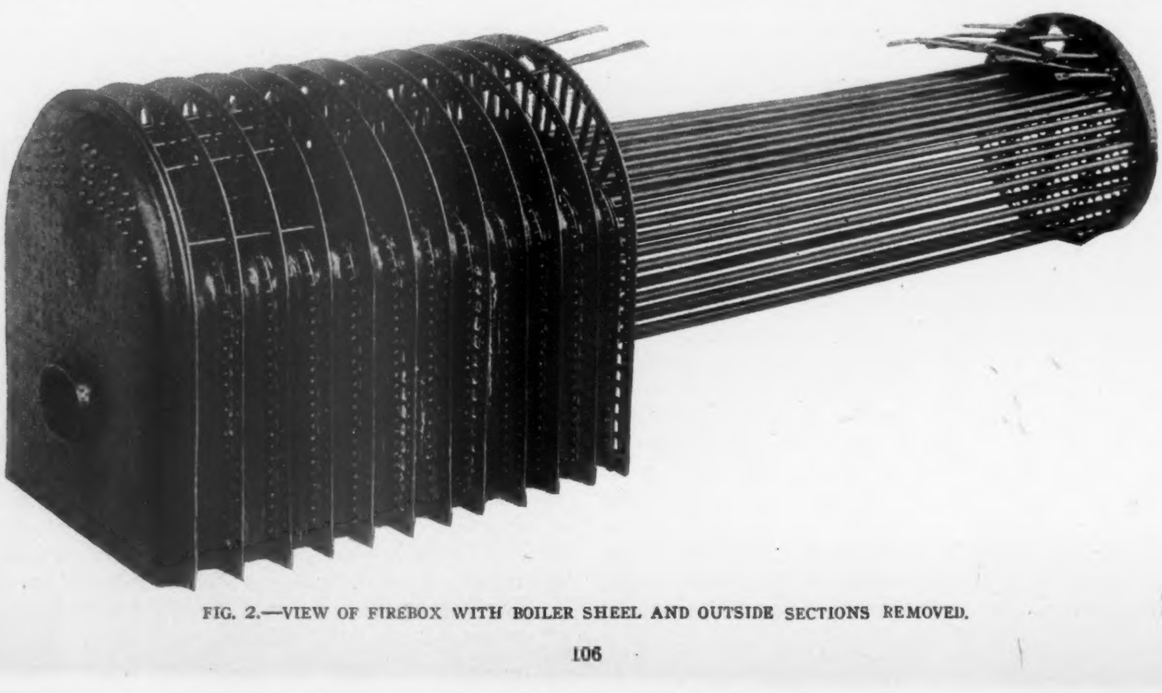


FIG. 2.—VIEW OF FIREBOX WITH BOILER SHEEL AND OUTSIDE SECTIONS REMOVED.

hold adjacent flanges. These sheets are partially cut away in the water leg, as shown in Fig. 2, to permit horizontal circulation of water around the firebox and the edges of the sheets form caulking strips for making tight joints between adjacent channel sections. All seams are submerged and no joints are exposed to the direct current of heat and gases. Due to the irregular outline thus formed for the firebox crown and sides, the available heating surface of the hottest section of the boiler is enlarged without increasing the size of the grate area. A mud-ring of either the ordinary type or a special design consisting of cast steel pockets, may be used.

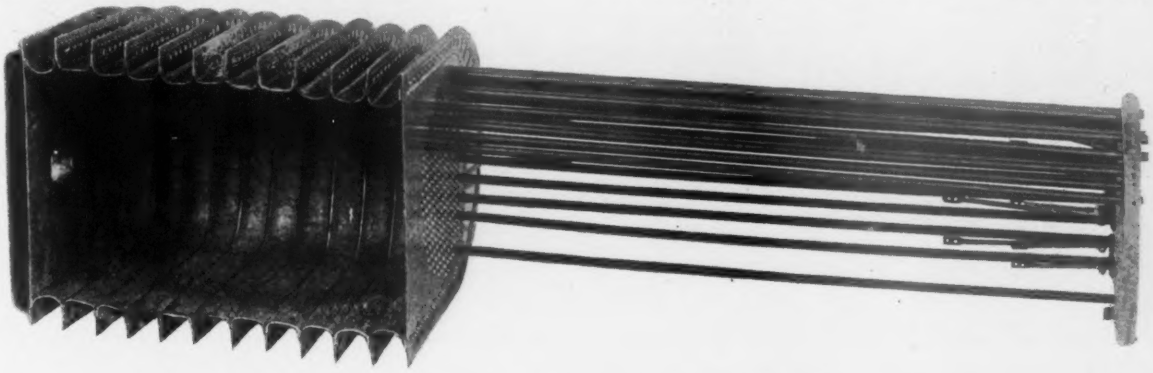


FIG. 3.—BOTTOM VIEW OF FIREBOX WITHOUT MUDRING OR OUTSIDE SHEETS.

In the fabrication of this firebox all the work is done by means of templets, jigs and formers, so that each one of the component parts is exactly like every other one, and all are interchangeable. This is achieved absolutely independent of the skill of the operators.

This construction presents many advantages over the usual design with very few counteracting disadvantages. The most striking features of advantage are:

SAFETY.

Due to its sectional construction this type of firebox is less liable to violent explosions than the ordinary type. Disastrous results of explosions with the ordinary firebox are shown in

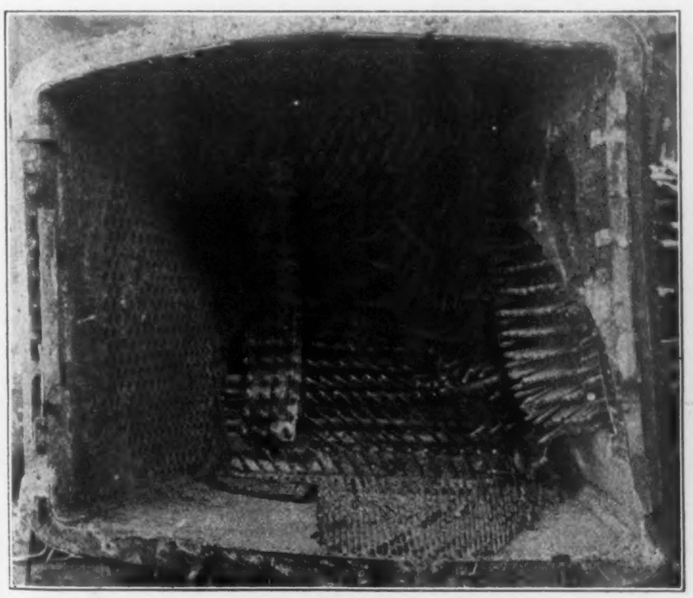


FIG. 4.—RUPTURED CROWN SHEET.

FIG. 5.—RUPTURED CROWN SHEET.

Figs. 4 and 5. With the ordinary construction when there is a weak place in the sheet, the pressure causes the sheet to be torn at that point. The larger the fracture, the larger is the leverage and the pressure acting with this increased leverage will rip out large portions of the sheet before it is relieved. It is the sudden opening up of these large holes that causes the violent explosions. There is practically nothing to check a break in the ordinary firebox sheet and, when it is once started, it is very liable to continue until much damage is done. In the sectional construction, however, it is impossible for a break to extend from one section to the other, and should a rupture occur in any section it will be simply a local break and cannot pass beyond the stay sheets to which the sections are riveted. The pressure will have no increased leverage to rupture the sheet in the original break, and consquently no violent explosion can occur which will give anything like the disastrous results shown in Figs. 4 and 5.

NO LOCALIZED STRESSES.

The arched, pressure-withstanding, concave construction (Fig. 6-c) of the sections insures that there will be no undue and enormous local stresses due either to the pressure or induced by large differences or sudden changes in temperature at different points. The shape of each section is such that it will expand or contract with variations of temperature, and produce only small stresses on the adjacent sections. This is not true of the usual firebox (Fig. 6-a). This sectional construction is specially adapted to relieve the excessive stresses that are set up in the ordinary construction by the local difference in temperature due to cold feed-water. When cold water is injected into the boiler, the temperature of the side sheet is very much reduced, and the effect is to contract the side sheet at its lower portion while it is expanded at its upper section. The forces induced by contraction and expansion, due to changes in temperature, are practically irresistible, and if no provision is made to take care of the contraction or expansion, there will be enormous local stresses set up in the metal.

Take, for example, a sheet six feet in length, and assume that its temperature is suddenly lowered by 200 degrees; the metal will contract until its length is reduced from 72 inches to 71.91 inches, or about .1 inch. If no provision is made to take care of this change in length, local stresses will be set up in the metal as great as 36,000 lbs. per square inch. This is the value of the elastic limit of good steel and three times as great

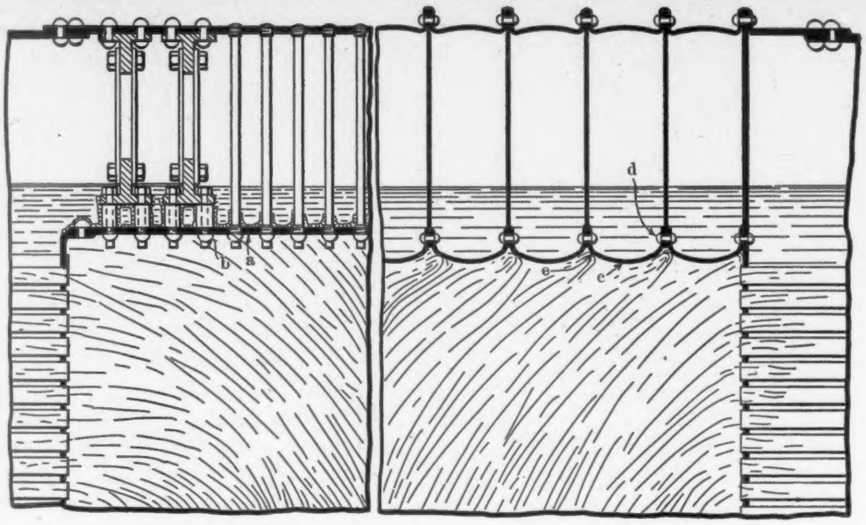
a pressure as should be used with safety under good conditions.

NO BURNED SEAMS.

All seams are submerged (Fig. 6-d), and thus are not subject to the danger of burning and leaking. The stay sheets between the channel and arch sections serve readily as caulking strips.

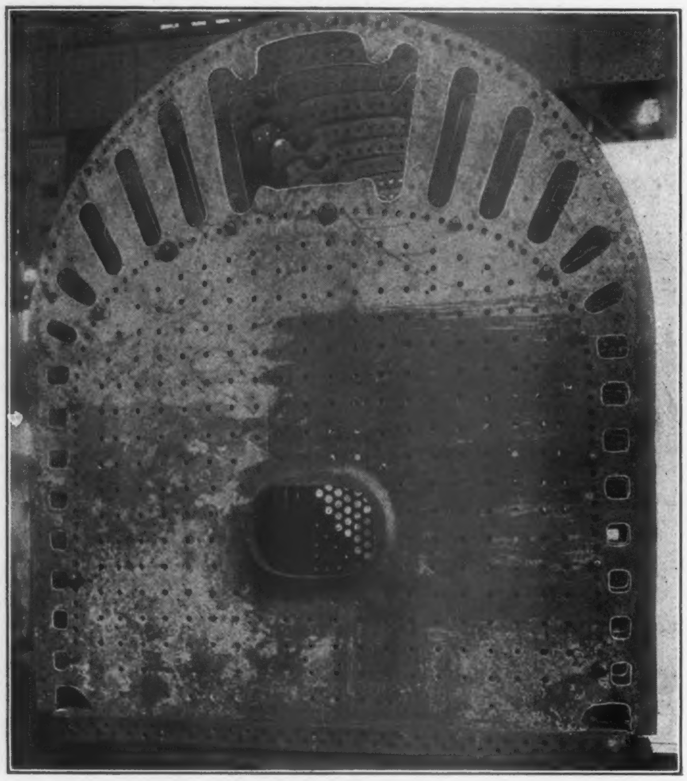
LOW MAINTENANCE COST.

Due to the design, and also to the absence of staybolts and crown-bar bolts, the maintenance cost of the boiler should be very much lower than with present usual construction. The maintenance cost would be approximately something over 40 per cent. less than is now the case. As the cost of maintenance and renewals of fireboxes, staybolts, and flues amount to an approximate expenditure of $2,000,000 per year on a road having 2,000 locomotives, this firebox should bring about a reduction of over $800,000 yearly in this expense.



Old Construction New Construction

FIG. 6.



VIEW SHOWING WAY IN WHICH STAY SHEETS ARE CUT OUT.

USES THINNER SHEETS.

Owing to the absence of large local strains from unequal expansion and contraction (Fig. 6-c) the firebox sections can be thinner than in the design with flat sheets and stays (Fig. 6-a); also owing to the absence of any side staybolts and crown-bolt heads (Fig. 6-b), the heat will be transmitted to the water more rapidly, and it will cause a greater evaporation for a firebox of the same grate area and heating surface, and per pound of coal burned.

It is a fact requiring no demonstration that heat flows from hotter bodies to cooler bodies. This transfer of heat, however, is not instantaneous, but continuous through a period of time. In two bodies of the same temperature no heat transfer takes place, and it is obvious that beginning with this condition, the transfer must be very slight and slow when one body is only a little hotter than the other. The diagrams (Figs. 7, 8, 9) will illustrate this.

In Fig. 7 the two bodies are of the same temperature, and there is no heat transference owing to the temperatures being balanced.

In Fig. 8 there is a slight and slow flow of heat from the warmer body to the colder owing to the small difference in the temperature. It is well known that the pressure of water from a standpipe increases with the increase in height—that is, with the difference between the level of the source and discharge. The same principle holds true of temperature levels.

In Fig. 9 the heat differences are relatively greater, and the heat flow consequently more rapid. This flow of heat takes place as indicated irrespective of whether the warm and cold bodies touch each other (or are indeed portions of the same object at different temperatures) or whether the heat has to traverse some intermediary, such as air, a wall of metal or other substance, or a body of water or other fluid. In the case of a fluid intermediary, the circulation assists the heat flow.

The transfer of heat through metal is usually considered proportional to the difference in temperature of the two sides of the metal. The greater the difference in temperatures, the greater the quantity of heat that passes through the metal in a given time.

This fact is shown graphically in Fig. 10. The hot gases are on one side of the metal and the colder water is on the other side. If the temperatures are plotted vertically, and the thickness plotted horizontally, lines connecting the two temperatures will give the relative rates of heat transference.

The steeper the line, the greater quantity of heat that will be transferred in a given time. For instance, the slope of the line AB is less than that of AC in Fig. 10, showing that less heat passes through the metal per unit of time when the water has a

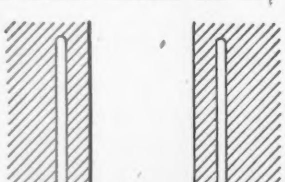


FIG. 7.

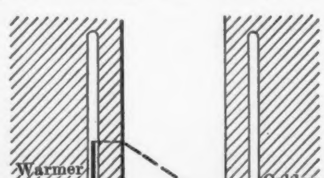


FIG. 8.

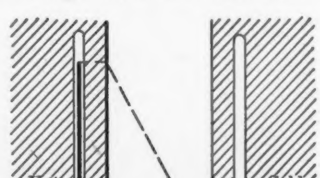


FIG. 9.

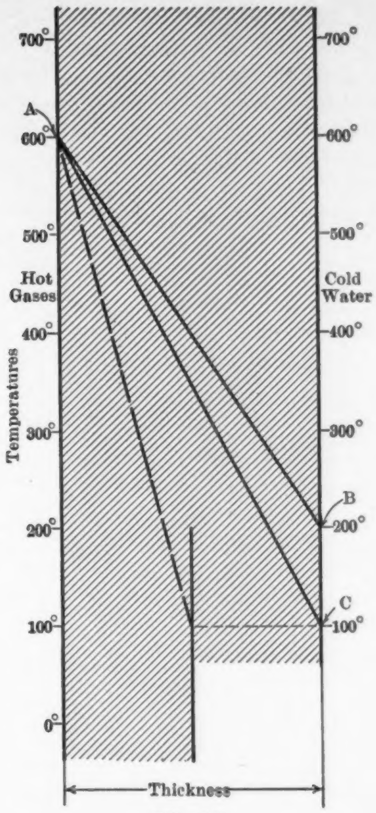


FIG. 10.

temperature of 200 degrees than when it has a temperature of 100 degrees.

If the metal were only half as thick and there was the same temperature difference, the slope of the heat flow line would be much greater, showing that more heat is transferred through thin than through thick metal in the same period of time.

Careful experiments, as well as mathematical demonstrations, show that heat is transferred through metal, not with a constant, but with a varying slope. The actual curve is similar to that shown in Fig. 11.

If horizontal lines are drawn through the temperatures to the slope curve, and vertical lines are then drawn, these vertical lines will divide the metal into portions of various width. The difference in temperature between the lines on the metal is always the same, for this case, 100 degrees. There is the same temperature head causing heat to flow, but because of the varying width of each section, the slope is less in each succeeding section. Heat flows less readily through H than through G, through G than through F, *et cetera.*

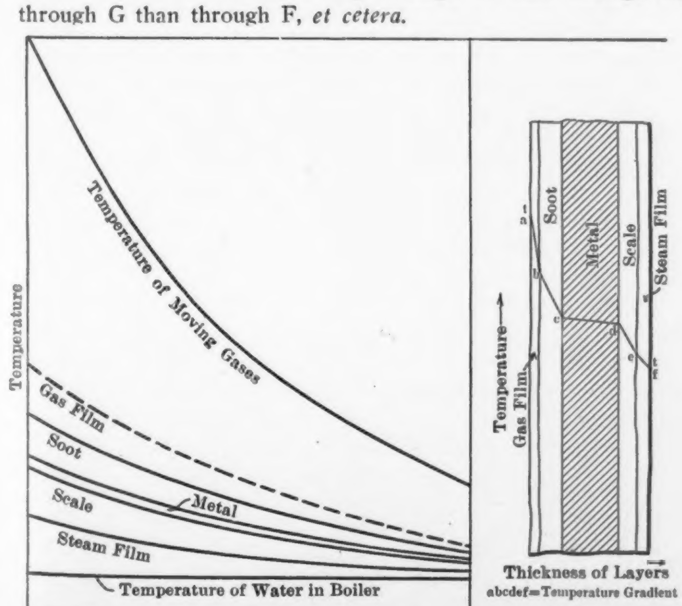


FIG. 12.

"In the theory of heat transmission the assumption is made that the gas comes directly into contact with the metal surface of the boiler flue, and also that the water in the boiler absorbs the heat as fast as the metal can transmit it. In a commercially operated boiler neither of these assumptions is true. The metal of the boiler flue is insulated from the gas with a layer of soot, and from the water with a layer of scale and, perhaps, a layer of steam (Fig. 12). As these layers of soot, scale and steam are very poor conductors, a resistance many times greater than that of the metal of the boiler tube itself is offered to the passage of heat. It is evident that under such conditions the difference of temperature between the first layer of gas and that of the first layer of water must be greater than it would have to be if the insulating layer of soot, scale, and steam were not present, in order that the heat should flow from the gas to the water at a certain desired rate. This temperature difference must be larger the greater the required rates of heat transmission and the thicker the insulating scales. Inasmuch as capacity is the rate of heat absorption, this explains why at higher capacities the gases leave the heating surface of a boiler at higher temperatures than they do at lower capacities. It is clear, then, that in order to have the heating surface efficient it must be kept free from soot and scale, and the bubbles of steam must be removed from the surface as fast as they form, so that the water can come directly into contact with the metal. This last requirement emphasizes the importance of water circulation in

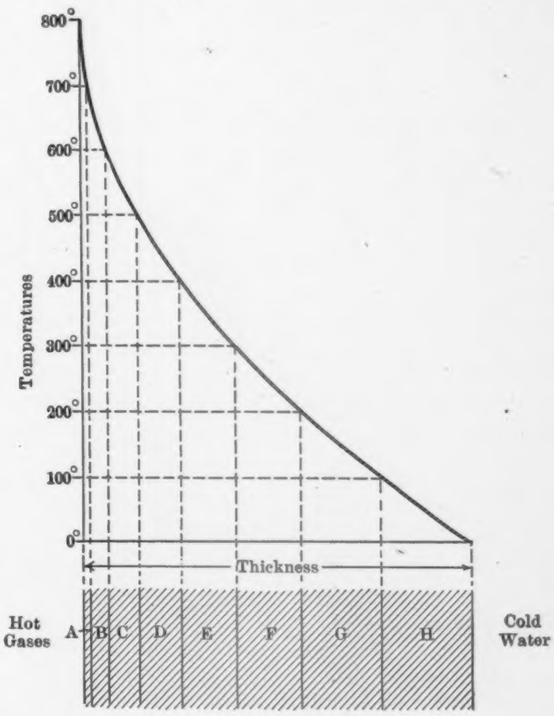


FIG. 11.

the boiler. The faster the circulation of water the faster are the bubbles of steam carried away and the better is the contact between the metal and the water." *

The comparative effect of heat on thick and thin plates can be illustrated by putting a postage stamp on the bottom of a tin drinking cup (Fig. 13-a), pasting it absolutely flat. Fill the cup with water and put a candle underneath the postage stamp. It will be found that the heat from the candle is absorbed so quickly in the water that it does not allow the stamp to be burned, the temperature of boiling water not being high enough to set fire to the stamp.

But should there be two thicknesses of tin, as in Fig. 13-b, and the same process tried, it would be found that the stamp would be charred or burned off.

If 1/16 of an inch of cement be deposited in the bottom of the cup (Fig. 13-c) it would be found that not alone would the

* Report of Prof. Breckenridge on St. Louis boiler tests. U. S. Geological Survey.

stamp be burned off, but the metal would be blue, due to the slow transmission of heat into the water.

The transfer of heat through irregular sections follows the same general law as just stated, but is more difficult to establish by experiment.

In Fig. 14 the lines of equal temperature are drawn for an irregular heating surface projecting into the water to be heated. A is the temperature of the metal next to the hot gases; for instance, it may be taken as 600 degrees. B is the line of temperature of 500 degrees throughout the metal, C is 400 degrees, D is 300 degrees, and E the temperature of the metal in contact with the cold water, is 200 degrees.

The transfer of heat through the crown sheet containing staybolts is rather more complicated, as shown in Fig. 15.

The surfaces A in contact with the hot gases will be at a high temperature and the heat wave will tend to travel across the metal perpendicular to the surface. The staybolt head is curved and the heat energy tends to concentrate. A portion of the energy in its travel will strike the inner portion of the head in an oblique direction. Because of the contact of two metals heat is reflected back from this surface and tends to travel outward toward the head of the staybolt. The effect is that the whole surface of the head of the staybolt gets very hot, while the surface of the sheet is much cooler because its heat has been transmitted freely through the unobstructed metal. In case, however, the surface E gets covered with a non-conductor and does not yield up heat freely, there is a tendency for the entire metal to get hot.

The transfer of heat through metal depends upon the action of the hot and cold bodies on either side of the metal. If there is a slow circulation, or no circulation, a small quantity of heat will be transferred. If the water circulates freely and rapidly, more water comes in contact with the surface in the same time and more heat is transferred.

If the heat is applied to the under side of a vessel containing water, the water will be rapidly heated. If the same heat is applied to the side of a vessel, the water will be heated very slowly. In the first case the heat is taken from the hot metal by convection of the bodily transference of the heat due to the motion of the heated water. In the second case, convection currents are not easily established and the heat is, for the most part, conducted through the water.

In a boiler the circulation is produced by convection, and it is of great importance to have a design that does not interfere with the water circulation in order to transmit heat.

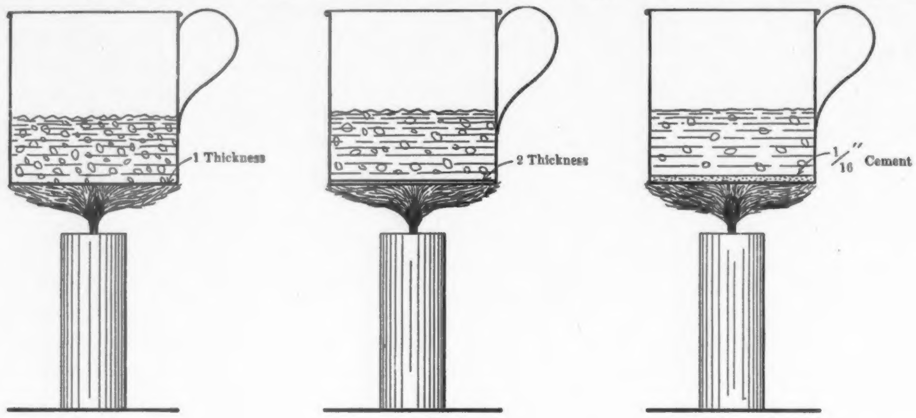


FIG. 13.

In the ordinary type the crown bars are a great obstacle to the free circulation of water in a boiler by convection. Referring to Fig. 6 the path of a particle of hot water leaving the sheet is seen to be obstructed by the crown bars which prevents free circulation, and makes the metal less efficient in transmitting heat.

In the other half of this figure it is seen that there is no obstruction to free circulation, and consequently there will be a high heat transference. In this type, the arched surfaces are more efficient in producing convection currents than the flat surfaces in the ordinary construction, due to the fact that less eddy-currents are set up.

LESS SCALE.

Since the water is generated into steam very much faster, we have very much better circulation. In consequence of better circulation, causing greater scrubbing action, and also, due to the expansion and contraction of each unit, scale will not adhere to firebox sheets.

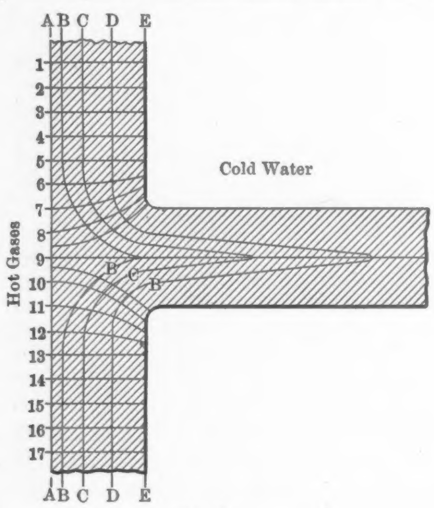


FIG. 14.

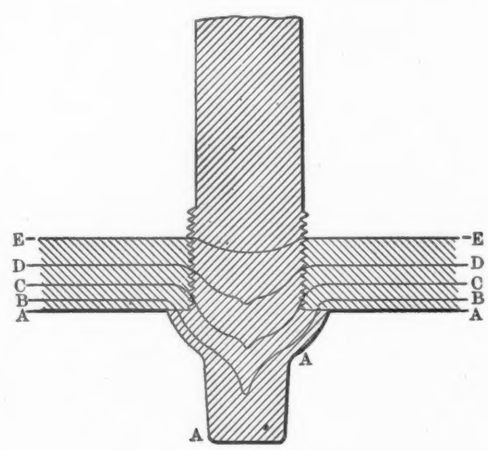


FIG. 15.

HEAT ABSORBED FASTER.

The corrugations of the interior walls of the firebox cause heat waves to be deflected into small eddies (Fig. 6-e) on the sheets, thus giving the heat units more time to pass through the sheet into the water and also scouring the soot off the sheet.

LONGER LIFE.

There will be much longer life in the flue sheet and flues, as they will be subjected to less strain on account of the ex-

pansion and contraction being taken up by the corrugated sections.

FUEL CONSUMPTION REDUCED.

There should be a reduction in the amount of fuel used per unit of power developed, equal to 12 per cent. This would appear either as a direct reduction in the total fuel cost, or as an increased gross ton mileage per ton of fuel consumed, and in either case the cost of fuel as a proportion of transportation expense would be reduced.

ROUNDHOUSE DELAYS REDUCED.

Detention of engines in roundhouses for boiler repairs should be so substantially lessened as to make engines available for service 8 to 16 per cent. more of their total time than at present, thus increasing the motive power available for traffic, and postponing the necessity for additions to this equipment.

[EDITOR'S NOTE.—All the features of design and construction of this firebox are fully covered by patents.]

OIL BURNING LOCOMOTIVES.

TO THE EDITOR:

Referring to the article in your January issue by Harrington Emerson on design of oil burning locomotives, the suggestions made by the author are, in my opinion, excellent as referring to design of a strictly oil burning locomotive boiler, but the items referred to as peculiar to burning oil fuel can be applied only, in practice, to construction of equipment for oil burning only. As the fuel supply of this country is somewhat indefinite as to quantity, it is impossible to predict, in the life of the locomotive, when it may not have to resume coal fuel. Hence, it does not appear, as a general proposition, that strictly oil burning equipment can be indefinitely maintained. With this in view there are some comments I would make on the items of Mr. Emerson's paper, as follows:

I agree that a larger combustion chamber for oil burning is required, not only in consequence of reduced friction referred to by Mr. Emerson, but because greater volume is required for combustion of volatile matter only. Ample space is required for proper mixing of air and hydrocarbons to complete combustion which properly should occur in the firebox and not in the flues for the following reasons:

If in an oil burning boiler sufficient firebox or combustion volume is not allowed, the hydrocarbon vapors must be consumed within the flues if burned at all. The purpose of flues in a steam boiler is to absorb heat from gases of combustion passing the furnace space. If these flues are fulfilling their office in absorbing heat, the temperature of the passing vapor falls rapidly. If small flues of sufficient length are used to deliver into the smokebox the least temperature, the vapors in process of combustion soon fall in temperature below that required for complete oxidation, hence there is a precipitation of soot. This, we know from experience, is very undesirable, as the soot is a non-conductor of heat and engines fall off in steaming capacity very rapidly as this deposit occurs. It is relieved by "sanding out," but this is not a prevention of the evil. It is my opinion that the smoking of oil burning locomotives is largely due to this, and it would be an error to place the smaller tubes unless we have a firebox amply large to insure complete combustion. It is my opinion that where oil burning is applied to ordinary locomotives, flues should be larger in diameter than they are now, instead of smaller.

The temperature of combustion maintained in our oil burning locomotives was recently determined by Dr. Arthur W. Gray, of the Department of Physics, University of California, who was conducting experiments for the University. The average temperature in hottest parts of the oil fire was found to be about 2,600 degrees F., observations ranging from 2,732 to 2,552 degrees F. While this is in excess of coal burning practice, under the same circumstances, by from 300 to 500 degrees F. the excess could hardly be termed "enormous," as referred to by Mr. Emerson. The temperature of smoke arch gases ranges from 870 to 820 degrees F. in our oil burning consolidated locomotives. In coal service this temperature ranges from 650 to 700 degrees F. The length of tube in these engines is fifteen feet. These boilers were designed for coal burning and evidently are forced in oil burning service. It is quite evident that if the combustion volume of the firebox were increased by diminishing length of flues, the engines would consume oil to better advantage. It appears, however, that the length of flues should remain; in other words, the whole boiler should be extended if it were designed for burning oil exclusively. In principle, any form of fuel used under a steam boiler should deliver its smoke arch gases at as low a temperature as possible, and the temperature should be the same for any fuel, but of course this can only be obtained by building boilers especially adapted for either fuel, which is the purpose of this reference.

As to severity of oil versus coal on firebox sheets and flues. We experienced considerable difficulty in the early history of our oil burning experience, from damage to firebox sheets, flue sheets, and tube ends. We did not consider this so much due to excessive temperatures as we did to the greater range of temperatures that must exist in a firebox supplied with either fuel. With coal fuel the solid mass in combustion on the grate serves as a reservoir of temperature, the control of which by dampers, etc., we are familiar with. In the use of oil fuel there is no fixed carbon or grates involved. The shutting off of oil fire leaves no bed of solid fuel to maintain even temperature. The difficulties are largely due to improper control of the extremes of temperature obtained in handling oil fires, from inexperience and carelessness of oil firemen.

From records we have kept as to cost of maintenance of coal versus oil burning locomotives, we know that if a furnace is properly equipped with draft adjustment as nearly perfect as it can be made by admitting the required amount of air and discharging the oil in the furnace at the proper temperature, preferably with superheated steam, and correctly regulated by the atomizer, the exhaust nozzle being as large as it will stand and getting sufficient draft on the fire to enable us to fill the whole interior of the furnace with a mellow flame, that an oil burning firebox will, under these conditions, outlast a firebox using coal. That is to say, on the same class of engine in the same class of service. However, as referred to above, it cost us a good many fireboxes to determine just what was the best arrangement.

In this connection it should be stated that the oil fireman is a large factor in successful oil burning practice on locomotives. Having the proper arrangement and draft appliances for oil burning it requires careful attention to business, and intelligence on the part of the fireman, with special training, to obtain best results. The personal equation enters largely into successful practice with oil burning. A careless fireman can do enormous damage on the locomotive.

San Francisco. HOWARD STILLMAN.

EFFECT OF FLAT WHEELS ON RAILS.

TO THE EDITOR:

I have read with interest the various letters on the effect of the flat wheels on rails in the AMERICAN ENGINEER AND RAILROAD JOURNAL and the *Railway Age Gazette*, and have noted the criticisms offered to the analysis given by the writer (AMERICAN ENGINEER AND RAILROAD JOURNAL, May, 1908, page 188).

It should be clearly understood that when this analysis was written the author made no claim for completeness, but on the contrary, stated that many factors had been omitted. Two points in the analysis have been criticised, namely: (1) The equating of the kinetic energy of the wheel to the energy of a hammer falling through a given height. (2) The concentration of the mass of the car at the center of the wheel.

EQUATING KINETIC ENERGY.

Regarding the first point I would say that I attempted to measure the kinetic energy of the wheel in terms of some known kinetic energy, and the most natural comparison was with the energy required in accepted impact tests. In using this comparison it is not necessary to consider that the length of the

flat spot is sufficient to break the rail. The idea was to equate the kinetic energy of the wheel to the maximum allowed for any given rail, and then taking a proper factor of safety, to get a safe length of flat spot. This method is entirely rational. It is the method used to get the safe tensile strength of materials, for example. In such cases the ultimate strength divided by a proper constant is always taken as the safe working strength.

It is true that in the impact test the rail rests upon supports three feet apart, while in the roadbed these supports are considerably closer, say 18 inches. This supposition, then, is on the side of safety. Everything considered, the writer is still of the opinion that no good reason has been advanced to show that the analysis is wrong in this particular.

CONCENTRATION OF MASS.

Regarding this point, the writer believes that it is more rational to consider only the mass of the rotating parts as concentrated at the center of the wheel. When this is done the "limiting velocity" is changed from five miles per hour to something like eighty miles per hour, as shown by George L. Fowler in the *Railway Age Gazette*, January 8, 1909. Under this assumption the effect of even small flat spots is very serious. The writer believes that with this change in his original assumption the analysis gives results much nearer the truth than those obtained by any analysis yet proposed.

In the analysis by H. H. Vaughan, in your journal, December, 1908, page 475, it is assumed that there is an upward force equal to $(Mv^2) \div r$, opposing the downward force, as soon as the wheel begins to turn about the forward edge of the flat spot. It is also assumed that the mass of all the parts below the springs may be included in M. This latter assumption is obviously wrong, since only rotating parts can have a lifting effect. Considering the assumptions made by Mr. Vaughan, the limiting speed is about fifteen miles per hour. While this analysis includes a factor neglected by any other, there seems some doubt as to whether or not the force $(Mv^2) \div r$ acts exactly as assumed.

It has been pointed out that many factors of importance in connection with the effect of impact of flat spots have been neglected; among those are the following:

(1) The swaying of the car from side to side, increasing at times the effect of the blow considerably.

(2) The elasticity of the track and roadbed, tending to decrease the effect of the blow.

(3) The bending of the rail, causing it to wrap around the wheel, lessening the blow.

(4) The decreased force of the spring as the wheel is forced downward.

It is obviously impossible to include all these factors in any mathematical analysis with any hope of obtaining results that will be of value. Indeed, it seems to the writer almost useless to extend mathematical work much beyond the present limits until some experimental confirmation of results are obtained. The matter now rests with the experimenter.

E. L. HANCOCK.

16-INCH BACK GEARED CRANK SHAPER.

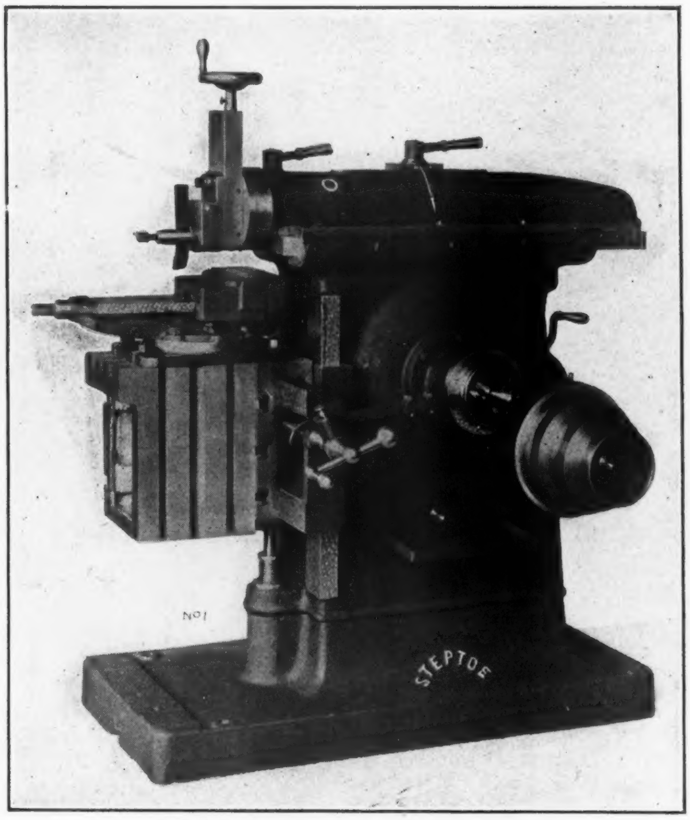
A number of new features have been incorporated in the newly designed 16-inch back geared crank shaper of The John Steptoe Shaper Company, Cincinnati, which is shown in the illustration. The head can be instantly loosened, so that it may be swiveled to any angle, by pushing the lever just back of it. It may be again instantly fastened securely in position, by pulling the lever toward the operator. This arrangement makes possible a considerable saving in time over the old method of fastening the head with bolts, and there is no wrench to be lost or misplaced.

The length of stroke is controlled by the shaft projecting through the feed plate and may be changed while the machine is in operation. There is no necessity of locking the shaft in position when the crank or lever with which it is operated is removed, since the device in the bull gear is self-locking. The ram is of substantial design, strongly ribbed and braced. The strength and stiffness of the operating side of the machine is increased by the basin-shaped projection or brace. The base of the machine is made heavier than the former designs.

The back gear ratio is 20 to 1 and the ratio in single gear 6¾ to 1. A single geared shaper of the same design is also made with a ratio of 6¾ to 1. The back gears are thrown in and out by the lever at the back of the column which is easily operated from the side of the machine. The driving gears are of phosphor bronze.

The shaft bearings are provided with cast iron bushings, which are pressed in, although they may be readily removed and replaced, if necessary. The shaft bearings are fitted with ring oilers, the ring carrying the oil from an oil well to the shaft, as it revolves, thereby affording constant lubrication. The rings are made of wide strips of brass, thereby having a liberal contact on the shaft, and distributing the oil more freely. It has been demonstrated that with a round ring the contact on the shaft is so small that comparatively little oil is distributed.

The feed plate is of an entirely new design. The feed eccentric is pivoted and may be swiveled in any direction. The holes in the plate are reamed tapered. The stud in the eccentric has a spring in it, and is also tapered. The tapered pin will



STEPTOE BACK GEARED CRANK SHAPER.

thereby take up any wear which may occur in this hole. The holes are drilled in a circle to keep them as far apart as possible. They are drilled and numbered to agree with the teeth in the feed ratchet, thereby making it easy to secure any desired feed. The ring which encircles the feed eccentric is split, and fitted with a fibre washer, thereby permitting any wear, which may occur in the ring, to be easily taken up by filing the washer.

There is no opening through the base of the machine in the pocket in which the telescopic screw operates; dirt and moisture are thus prevented from getting in at the bottom. The graduations on the vise base are placed on an angle so that they may be more easily read by the operator. In fastening the work in the vise the upper jaw has a tendency to raise as the work is tightened. To overcome this the upper jaw may be firmly clamped to the lower one by two bolts as shown.

RAILROAD CLUB ACTIVITIES

Canadian Railway Club (Montreal, Can.)—The meeting scheduled for April 6 is on "Snow Fighting," by A. W. Wheatley and T. McHattie.

At a January meeting the paper presented by Mr. Kinkead on "Locomotive Springs" was received with much interest and given an extended discussion. The experience in the making and use of springs from steel of both British and American manufacture, given by a number of the members, formed a very interesting part of the discussion. In reply to a question the author of the paper stated that he knew of no Vanadium steel springs in use in that country (Canada), although there were a number in service across the line, but he was unable to give any data showing results.

The seventh annual dinner of the club was held on Friday evening, January 29, with about 170 members and guests present. The President gave a brief address, drawing attention to the value of railroad clubs to all classes of employees and pointing out that no matter how minor a position a man occupies on a railway system his work is important and worthy of study. Toasts were responded to as follows: "The Railways," by G. E. Drummond, C. Murphy and G. T. Bell. "Our Guests," by Mr. Goodchild and Cy. Warman. "The Railway Supply Men," by S. King and J. S. N. Dougall. The members present were also entertained by a quartette and by humorous remarks from George Armstrong.

Secretary, James Powell, P. O. Box 7, St. Lambert, near Montreal, Can.

Central Railroad Club (Buffalo, N. Y.)—The next meeting will be held at the Hotel Iroquois on the evening of Friday, March 12, at 8 o'clock. The paper will be by John M. E. Ames, mechanical engineer of the American Car & Foundry Co., on "The Use of Steel in Passenger Car Construction."

Secretary, H. D. Vought, 95 Liberty St., New York.

New England Railroad Club (Boston, Mass.)—At the February meeting a paper by Henry C. Boynton, on "Steel Rails," which was illustrated by stereopticon views, brought out the largest attendance so far this year. The discussion of the paper was equally interesting. J. P. Snow, bridge engineer of the Boston & Maine Railroad, showed some slides on the same subject, as did also Professor Henry Fay, of the Massachusetts Institute of Technology.

The next regular meeting will be held at the Copley Square Hotel, Boston, March 19. Dinner will be served at 6.30 P. M. to be followed by the regular business session at 8 P. M. The paper will be by A. W. Martin, superintendent of the Boston Division of the N. Y., N. H. & H. R. R., on the subject of "The Railroad Club—Its Worth." The following subjects will also be discussed at this meeting: "The Abuse of the M. C. B. Repair Card" and "The Rules of Interchange of the M. C. B. Association." This will be the annual meeting of the club and election of officers will take place.

Secretary, George H. Frazier, 10 Oliver St., Boston, Mass.

New York Railroad Club.—At the meeting of February 19 a paper entitled, "The American Railway Association's Bureau for Safe Transportation of Explosives and Other Dangerous Articles," was presented by Col. B. W. Dunn. In this paper Colonel Dunn explained the reasons for the formation of the bureau; the difficulties which it has met and overcome; its plans for the future and the large amount of good that it had already been able to accomplish. He made a plea for more general interest in the work which the bureau is doing, especially in connection with helpful suggestions.

The March meeting will be given up to the annual electrical discussion, which has always been a very popular feature of this club's activities. The best known authorities on steam railway electrification speak at this meeting, which will be held on March 19, at the Engineering Societies Building, 29 West 39th St., at 8 P. M.

Secretary, H. D. Vought, 95 Liberty St., New York.

Northern Railroad Club (Duluth, Minn.)—The paper scheduled for the next meeting, Saturday evening, March 27, is on "The Soliciting of Freight; The Carrier and the Shipper," by W. H. Smith, assistant general agent, Northern Pacific Railroad.

At the January meeting the discussion was taken up on Mr. Clark's paper on "Concrete and Steel Ore Docks vs. Wooden Ore Docks." The general consensus of opinion seemed to be that the concrete offered a great many advantages for ore dock construction, and that it would undoubtedly be extensively used in this connection. Some trouble in the matter of freezing in cold weather had occurred, but it was not believed that this would be serious.

N. P. White, roundhouse foreman, Northern Pacific Railway, Duluth, presented a paper on "Engine Repairs in the Roundhouse, From the Standpoint of a Machinist." This briefly reviewed the changed conditions a roundhouse foreman has to meet at present compared with those of a number of years ago, which have added greatly to his burden and responsibility. The matter of making work reports was considered briefly and the custom of making strictly temporary repairs was depreciated.

A paper on "Boiler Repairs in the Roundhouse, From the Standpoint of a Boiler Maker," by Claude Richards, foreman boiler maker of the C., St. P., M. & O., was presented. This pointed out how much boiler trouble could be avoided by using proper care in washing out and also in making careful repairs.

Secretary, C. L. Kennedy, 401 W. Superior St., Duluth, Minn.

Railway Club of Pittsburgh.—The next meeting, on March 26 will be given up to a discussion of the report of the standing committee on "The Revision of M. C. B. Rules of Interchange" and the subject of "The Abuse of the M. C. B. Repair Card."

Secretary, C W. Alleman, General Offices, Pittsburgh & Lake Erie Railroad, Pittsburgh, Pa.

St. Louis Railway Club.—The February meeting was held on the evening of February 12, at the Southern Hotel, and was one of the most enthusiastic ever held by this club, there being over 400 members and visitors present. The paper presented was by W. E. Harkness on "Train Dispatching by Telephone." After the regular meeting a practical demonstration of the telephone in connection with the selector for train dispatching was given.

The paper for the meeting of March 12 will be by D. T. Taylor, foreman of the car department of the St. L. & S. F. Railroad, on "Piece Work in the Repair Shop."

Secretary, B. W. Frauenthal, Union Station, St. Louis, Mo.

Western Railway Club.—The paper for the March 16 meeting will be by W. L. Park, general superintendent of the Union Pacific Railroad, on the subject of "Publicity for Railroad Accidents."

The paper by R. B. Dole, assistant chemist of the Water Resource Branch of the U. S. Geological Survey, on the "Quality of Surface Waters in the North Central States," presented at the February meeting, proved to be very interesting and was fully dis-

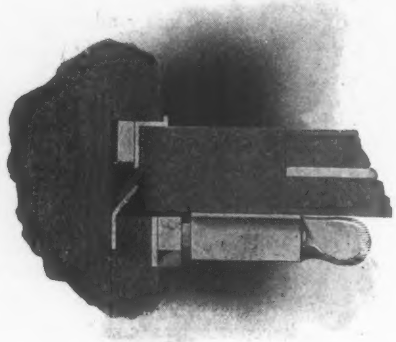
cussed, principally by the chemists of the various railroads entering Chicago.

Secretary, J. W. Taylor, 390 Old Colony Bldg., Chicago, Ill.

Western Canada Railway Club (Winnipeg, Man.)—A club has been organized with headquarters at Winnipeg, Man., which will hold regular meetings on the second Monday of each month, excepting June, July and August. At the intial meeting the following officers were elected: Hon. president, William Whyte; hon. vice-presidents, M. H. McLeod, G. J. Bury, G. W. Caye and Wilford Phillips; president, Grant Hall; vice-president, L. B. Merriman; secretary, W. H. Roseberry; treasurer, T. Humphries; executive committee, R. J. Hungerford, C. W. Cooper, J. McLenzie, W. Smith, R. McNeil and L. O. Moody.

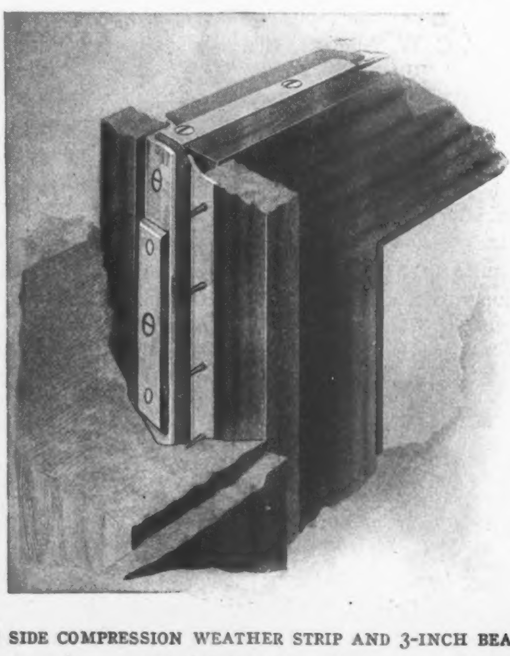
SOME NEW CAR WINDOW FIXTURES.

The matter of having windows in passenger cars air and dust tight, non-rattling, and at the same time capable of being easily raised and secured at any desired height, is a very important one and is being given careful attention in modern passenger cars of all classes. Inventors are giving this subject thorough study and among the recent products of their energy are the system of weather stripping, dust deflectors and sash locking devices, shown in the accompanying illustrations, which would appear to fulfil the desired conditions perfectly.



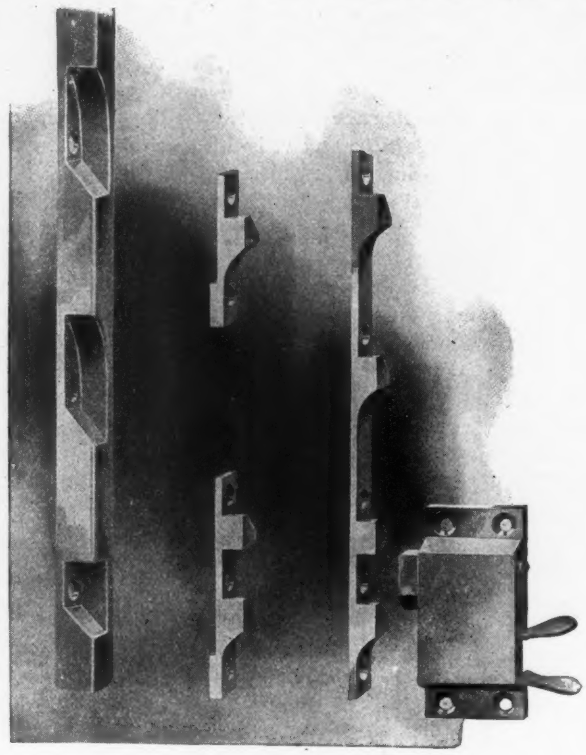
TOP VIEW OF WINDOW FIXTURES IN OPERATIVE POSITION.

With this arrangement the sash is fitted loosely between the stops, there being sufficient clearance to allow it to be easily raised and lowered at all times without binding. This opening around the loosely fitted sash is positively sealed air tight and dust proof by the weather strip forming a flexible joint. The illustrations show these strips in position on the window and make it evident that it will fulfil the purpose for which it is designed.



VIEW OF SIDE COMPRESSION WEATHER STRIP AND 3-INCH BEARING AT TOP CORNERS OF SASH.

For preventing the rattle and to prevent the sash from falling, a gravity wedge locking device is used. The lock bolt in this case is beveled at an angle of 45 degrees, and sets into a corresponding downwardly and outwardly beveled rack. This arrangement permits the weight of the sash to force it to a bearing against the outside stop and not only prevents it rattling, but also permits it to come to a gradual stop when lowered and eliminates any sudden jar, such as would loosen the fixtures or break the glass. A number of different designs of racks for these locks are shown in the illustration.



GRAVITY WEDGING SASH LOCK AND RACKS.

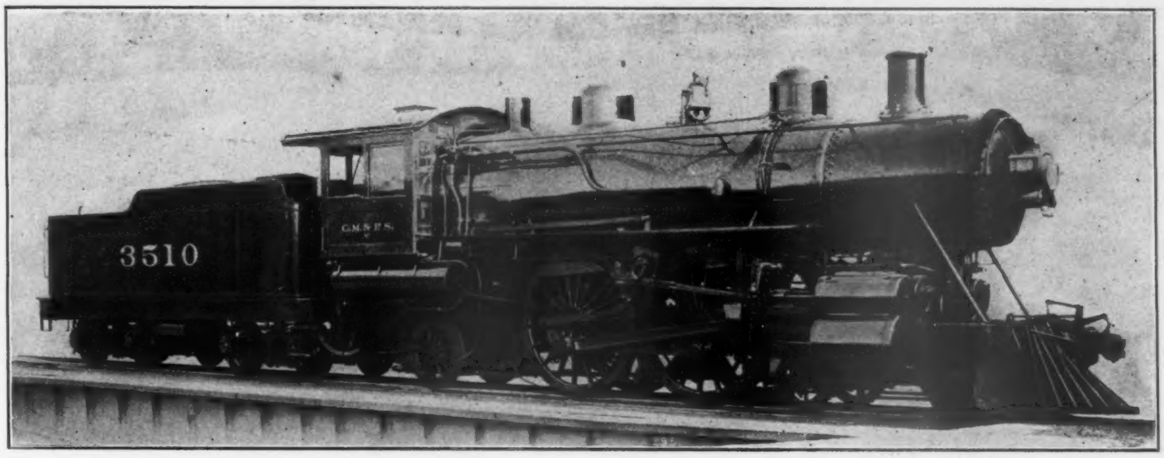
These devices are manufactured by the Grip Nut Company, 1590 Old Colony Building, Chicago, which also has a number of other improvements in car window fixtures, suitable for either wood or steel cars.

CONDITION OF COUNTRY'S FOREST RESOURCES.

The forests of the United States now cover about 550,000,000 acres, or about one-fourth of the land of the whole country. The original forests covered not less than 850,000,000 acres, or nearly one-half. The forests owned by the government cover one-fourth of the total forest area, and contain one-fifth of all timber standing. Forests privately owned cover three-fourths of the area, and contain four-fifths of the standing timber.

Forestry, or conservative lumbering, is practiced on 70 per cent. of the forests publicly owned and on less than 1 per cent. of the forests privately owned. The chairman of the section of forests of the National Conservation Commission, in outlining the future recently said:

"By reasonable thrift, we can produce a constant timber supply beyond our present need, and with it conserve the usefulness of our streams for irrigation, water supply, navigation, and power. Under right management, our forests will yield over four times as much as now. We can reduce waste in the woods and in the mill at least one-third, with present as well as future profit. We shall suffer for timber to meet our needs, until our forests have had time to grow again. But if we act vigorously and at once, we shall escape permanent timber scarcity."



VAUCLAIN COMPOUND ATLANTIC TYPE LOCOMOTIVE.

CHICAGO, MILWAUKEE & ST. PAUL RAILWAY.

The Baldwin Locomotive Works has recently completed an order of twelve Atlantic type locomotives, of the original Vauclain four-cylinder compound type, for the Chicago, Milwaukee & St. Paul Railway. This road has had an experience with this type of locomotive which dates back to the year 1896, when two engines were placed in high speed service between Chicago and Milwaukee. Subsequent orders of similar construction were made, and in 1901 a new design, employing the same type of cylinders but of much heavier construction, with a wide firebox, was prepared and a number built.

The service which these locomotives have been satisfactorily performing in handling heavy passenger trains is outlined as follows: Trains Nos. 5 and 6, running between Chicago and Minneapolis, normally made up of 10 cars weighing 508 tons, are scheduled to cover the distance of 420 miles between the two cities in 13 hours and 45 minutes, or an average speed of 30½ miles per hour, which, in view of the fact that the schedule calls for 45 stops and the trains are often composed of 13 or 14 cars, is a very creditable performance. On trains Nos. 1 and 4, between Chicago and Milwaukee, the distance is 85 miles, and the time is 2 hours and 10 minutes, or an average speed of 39.3 miles per hour. This includes three stops and a speed of 12 miles per hour within the city limits. These trains are frequently composed of 14 cars weighing 750 tons, and at times 16 cars are handled. On the run between Chicago and Omaha, a distance of 492 miles, trains of 7 cars, weighing 372 tons, are operated in 13 hours and 40 minutes, including 45 stops. A train of 11 cars, weighing 552 tons, covers the distance in 14 hours and 30 minutes and makes 25 stops.

This is a very creditable operation, especially for a four coupled locomotive and explains the last order of the same type of locomotive, which is different only in details from those now in service.

The cylinders are 15 and 25 x 28 in. and have the high pressure cylinder placed on top. The steam distribution on each side is controlled by one 15 in. piston valve driven by a Walschaert valve gear. The valve being necessarily set inside the cylinders, requires the introduction of a rocker, which will be seen secured in front of the guide yoke and connecting directly to the combination lever. The inner arm operates the valve through a short valve rod provided with a knuckle joint.

The frame bracing is most substantial and comprises a broad steel casting over the main driving pedestal, a cross steel casting at the front end of the mud ring and a steel casting at the guide yoke. The main frames are of cast steel and have single front rails. The rear extension or trailer frame is of the slab types 10 in. deep and 2½ in. wide, being adapted to accommodate the DeVoy type of trailer truck. In this truck the wheels have inside journals and both journal boxes are formed in the same casting which extends across the locomotive. It is guided by cast steel pedestals and the weight is transferred to it through steel rollers over each box. It has about 2½ in. lateral motion and requires no radius bar.

A conspicuous feature of the boiler design is the depth of the throat, the bottom of the mud ring being 28½ in. below the underside of the barrel. The grate is equipped with drop grates, front and rear, and a brick arch supported by four 3 in. tubes, is provided.

The smokebox is of the extension type and is fitted with a high double nozzle with a petticoat pipe. Provision for washing out the boiler has been given careful attention and includes a large number of wash-out plugs, there being six on the front tube sheet.

The general dimension, weights and ratios of this locomotive are as follows:

GENERAL DATA.	
Service	Passenger
Tractive effort, compound	22,200 lbs
Weight in working order	210,400 lbs.
Weight on drivers	108,750 lbs.
Weight on leading truck	55,950 lbs.
Weight cn trailing truck	45,700 lbs.
Weight of engine and tender in working order	343,000 lbs.
Wheel base, driving	7 ft. 4 in.
Wheel base, total	29 ft. 2½ in.
Wheel base, engine and tender	60 ft. 7 in.

RATIOS.	
Weight on drivers ÷ tractive effort	4.90
Total weight ÷ tractive effort	9.65
Tractive effort × diam. drivers ÷ heating surface	592.00
Total heating surface ÷ grate area	70.80
Firebox heating surface ÷ total heating surface, per cent	6.73
Weight on drivers ÷ total heating surface	34.30
Total weight ÷ total heating surface	66.00
Volume equivalent simple cylinders, cu. ft	9.20
Total heating surface ÷ vol. cylinders	346.00
Grate area ÷ vol. cylinders	4.90

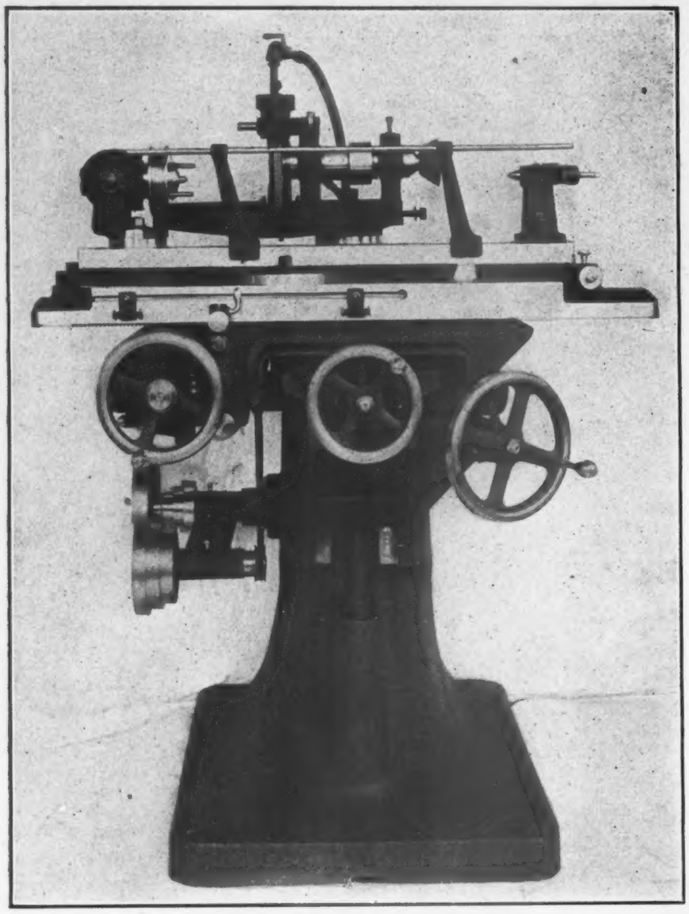
CYLINDERS.	
Kind	Compound
Diameter and stroke	15 & 25 x 28 in.

VALVES.	
Kind	Piston
Diameter	15 in.
Greatest travel	5¼ in.
Lead H. P.	3/16 in.
Lead, L. P.	5/16 in.

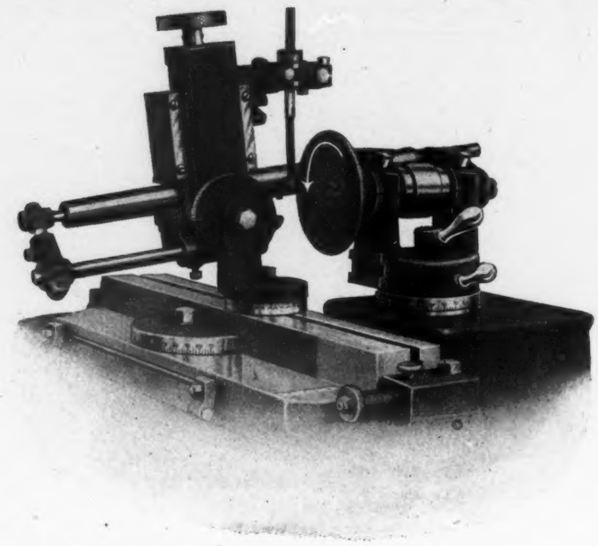
WHEELS.	
Driving, diameter over tires	85 in.
Driving journals, diameter and length	10 x 12 in.
Engine truck wheels, diameter	33 in.
Trailing truck wheels, diameter	43 in.

BOILER.	
Style	Wagon Top
Working pressure	220 lbs.
Outside diameter of first ring	66 in.
Firebox, length and width	107⅛ — 59¼ in.
Firebox plates, thickness	S. & B.—⅜, C—7/16, T—½ in.
Firebox, water space	F-4½, S. & B. 4 in.
Tubes, number and outside diameter	346-2 in.
Tubes, length	16 ft. 6 in.
Heating surface, tubes	2,974 sq. ft.
Heating surface, firebox	214 sq. ft.
Heating surface, total	3188 sq. ft.
Grate area	45 sq. ft.
Smokestack, height above rail	179 in.
Center of boiler above rail	113½ in.

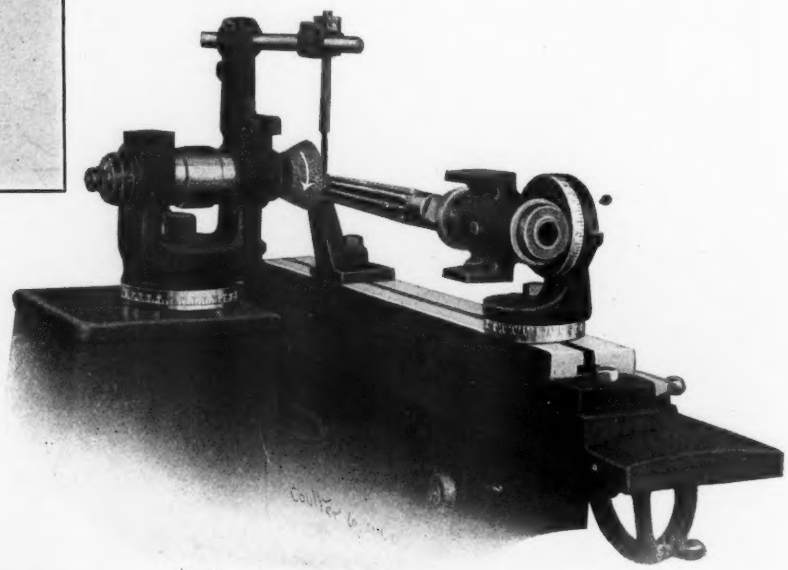
TENDER.	
Wheels, diameter	33 in.
Journals, diameter and length	5½ x 10 in.
Water capacity	7000 gals.
Coal capacity	10 tons.



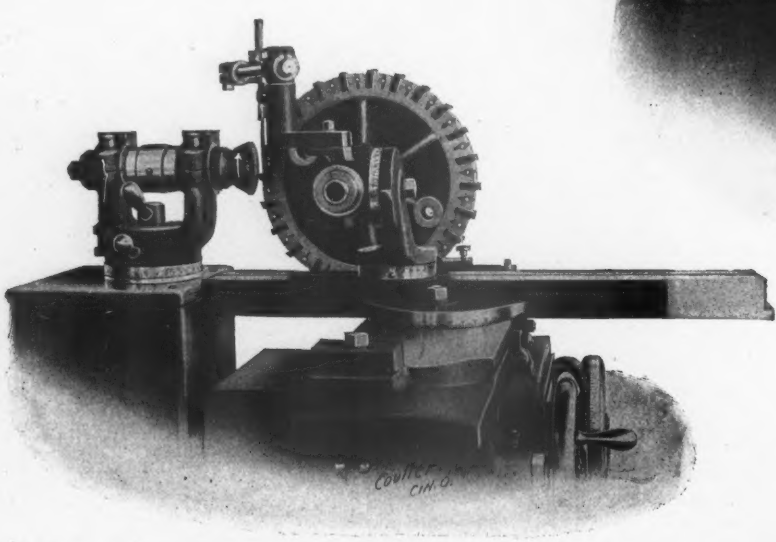
OESTERLEIN UNIVERSAL CUTTER GRINDER.



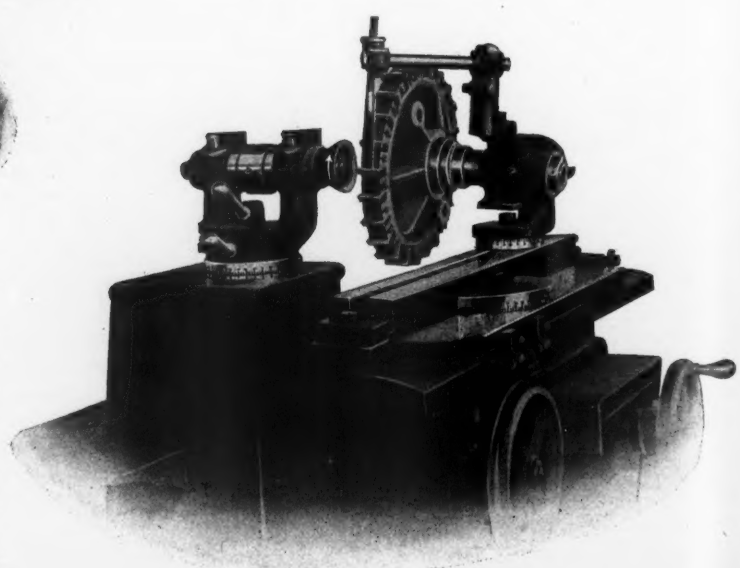
SHARPENING CUTTER IN STRAIGHT BAR.



SHARPENING TAPER REAMER.



SHARPENING PERIPHERY OF INSERTED TOOTH MILLING CUTTER.



SHARPENING FACE OF AN INSERTED TOOTH MILLING CUTTER.

UNIVERSAL CUTTER GRINDER.

This machine, known as the No. 3 universal and tool grinder, and manufactured by The Oesterlein Machine Company, Cincinnati, Ohio, is adapted for grinding all cutters and tools used in a machine shop and also for cylindrical work within its capacity. The chief difference between this new design and the No. 2 machine are the addition of an automatic feed, having six changes, and a pump and tank for providing a plentiful supply of water. The water guards and shields are adjustable and may be quickly removed, if necessary. The feed may be reversed within very close limits, allowing work to be ground close to a shoulder.

The spindle head has a two-step cone pulley thus furnishing two speeds for the grinding wheel; it is graduated and may be swiveled to any angle. The table has a bearing its entire length on the slide and is graduated and may be turned clear

around and clamped in any position on the slide. There is also a scale on the slide which indicates the amount of taper per foot. The taper setting may be delicately adjusted by means of a worm and worm wheel at one end of the table. The slide has a V and a flat bearing on the saddle and the saddle has a V and flat bearing on the knee, thus insuring that the cross movement will at all times remain at right angles with the longitudinal movement.

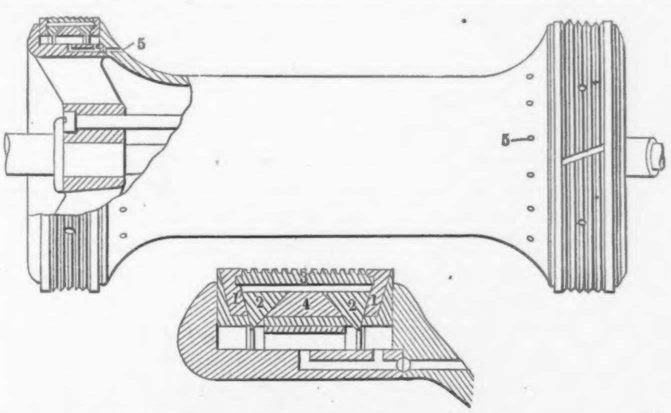
The headstock may be swiveled and clamped in any position in the vertical or horizontal plane. The tailstock has a compensating center and is actuated by a lever, making it very convenient to withdraw the centre from the work. The vise when mounted on the headstock swivels in any angle; it is provided with a V block to fit the lower jaw for holding circular work; the upper jaw swivels to accommodate any taper. A tooth rest is furnished which is universal in construction and has a micrometer adjusting nut for accurate setting in any position.

A simple device on the countershaft obviates the use of a tight and loose pulley. The table has an automatic feed of 16 inches, a transverse movement of 8 inches and a vertical movement of 7½ inches. It takes 24 inches between centres and swings 9 inches, or 12 inches, with raising blocks. The grinding wheel spindle operates at 2,942 and 4,080 r. p. m. and the table feed at the rate of 8, 11½, 16½, 24, 34 and 60 inches per minute. The machine weighs about 1,400 pounds. To give some slight idea of the range of work for which it is intended several illustrations are presented showing various operations on the No. 2 machine.

AMERICAN SEMI-PLUG PISTON VALVE.

The valve which is shown in the accompanying illustration is called a "semi-plug" piston valve because when drifting, or at any time with the steam shut off, it acts like a snap ring valve, that is, the packing rings are expansible and adjust themselves to the valve chamber, but, when steam is turned on, it becomes a plug valve due to the pressure acting on the wedges, as will be explained below, and locking the snap rings at a fixed diameter.

It is, of course, of great importance for securing the best service from piston valves to have the cages perfectly true, and this condition would be best maintained by a plug valve. It is also of importance, for a satisfactory valve, to prevent lateral wear which will allow steam to blow around and underneath the rings.



It is for the purpose of fulfilling these requirements that this valve has been designed.

Referring to the sectional view, it will be seen that the packing consists of two snap rings (1) which have straight outside faces fitting against the straight wall of the follower and spool. The inner faces of the snap rings, however, are beveled. Inside of these are a pair of rings, (2) which are called wall rings. These are uncut, non-expansible, steel rings and are beveled at different angles on the two sides, as shown. Between these fits an expansible ring called a wedge ring (4). An expansible ring, (3) with grooves which forms the actual packing and bears on the cage, fits between and interlocks with the snap rings. This ring is wide enough to carry the snap rings across the port when drifting, and it also acts to keep them parallel with each other.

The operation of this packing is as follows: When steam is turned on, with an internal admission valve, it enters through the holes, (5) in the spool, of which there will be from 14 to 18 on each end, and thus gains admission beneath the packing. Its first action is to force out the first snap ring, which will also carry with it the second through the wide packing strip, and then acts to force out the expansible wedge ring, which wedges outward the non-expansible wall rings, which in turn force the snap rings against the walls of the follower and spool and hold them solidly in position. The angles on either side of the wall rings are carefully calculated so that the pressure is just sufficient to hold the snap rings in position, but not sufficient to reduce them in diameter. The importance of this is evident when it is considered that if it is too large it will force the snap rings inward, while if it is too small it will not prevent the steam underneath forcing the rings outward and thus defeat the desired plug effect.

The complete packing is entirely free to move up and down on the spool, which will permit it to fit the cage perfectly, regardless of any variation in the centering of the spool. It is, of course, disastrous to a valve cage to allow the weight of the spool to ride upon it and with this type of packing the spool must be carried by the valve rod.

The design of this packing is such, however, that in case the packing is locked at a point in the cage that is larger in diameter than at some other point the movement of the valve will force it down to the smaller diameter, where it will remain. From this it will be evident that this valve will not wear a cage out of true and it is also evident that it is important to have a true cage to begin with.

This design of piston valve is manufactured by the American Balanced Valve Co., Jersey Shore, Pa., and has proven in actual service to fulfil all the conditions for which it is designed.

FILES OF PRECISION.

In the manufacture of files, the American makers have heretofore confined themselves very largely to the production of those which can be produced in large quantities and of a grade that can be sold at low prices, leaving it almost entirely to the Swiss file makers to supply the more limited, but important, demand for the better quality of file needed by tool makers, die sinkers, jewelers and manufacturers of fine tools and instruments generally. For work of this kind the ordinary American file is not sufficiently accurate in shape and gradation of cuts.

To produce these "Files of Precision," as they are called in Switzerland, the Swiss makers have a large body of highly skilled artisans whose wages in comparison with American labor are very low, only exceptionally good workmen receiving as much as one dollar a day. The Swiss file is the outgrowth of the Swiss watch industry, which is about 200 years old. These watches are made quite largely by hand, so that the production of files of the very highest grade early became a vital necessity in that country. The excellence of these files is largely due to the manual skill of the man who forms the teeth and the careful inspection which rejects all below a required high standard.

Even under the present protective duty, files of this grade could not be made in America by the same methods employed in Switzerland, and it is evident that new methods had to be devised in order to produce files of precision in the United States under American conditions, which would be of the same quality and able to compete with the imported product. These methods have been devised and are in use at the factory of the American Swiss File & Tool Company at Elizabethport, N. J., which is at present said to be the only manufacturer of these high quality files in the United States. Its methods of manufacture differ essentially from those of any other file factories either here or in Europe and the conditions which make it possible for these makers to compete with the imported product are briefly summed up as follows: An exact scientific method of annealing, which reproduces the same conditions day after day and year after year; the use of machinery in cutting the teeth, made possible by the uniformity of annealing, and thus greatly reducing the

cost of cutting; the carefully devised scientific methods of hardening, reproducing exactly the same results continuously; and, finally, the greatest care and conscientiousness in the inspection of the finished product.

In making these files in America no improvement has been attempted in the shapes and sizes of the blanks and the fineness of the teeth used in Swiss files, which have been developed by the needs of the most skilful workmanship in the world, but in all other respects these files are not an imitation of either Swiss or American files and the machines used for making them have been altered and improved materially, so as to perform their work with greater precision. This company, therefore, claims to have established a new and rather difficult branch of industry, not by imitating any one, but devising new methods in forming and shaping the blanks, in cutting the teeth and notably, in the process of forging, annealing and hardening.

American mechanics are able to appreciate tools of this class and these makers are receiving large numbers of complimentary letters from such men. They are willing to let their product speak for itself by furnishing samples, to be used in competition with other makes, to any one desiring to make a competitive test. The address of the company is 24 John street, New York City.

BORING JIGS IN THE MANUFACTURE OF SHAPERS.

It is of great importance in the manufacture of shapers to have the most accurate and uniform work in all parts if the finished tool is to be of the highest character and capable of the best grade of work. A shaper is subjected to many unusual stresses, because of its method of driving, the large overhang of the driving cone and the many holes and joints in which lost motion would be fatal to the best results. If the utmost care is not given to these features in the manufacture the machine is not only not capable of performing the service desired, but it soon wears itself into a comparatively useless condition.

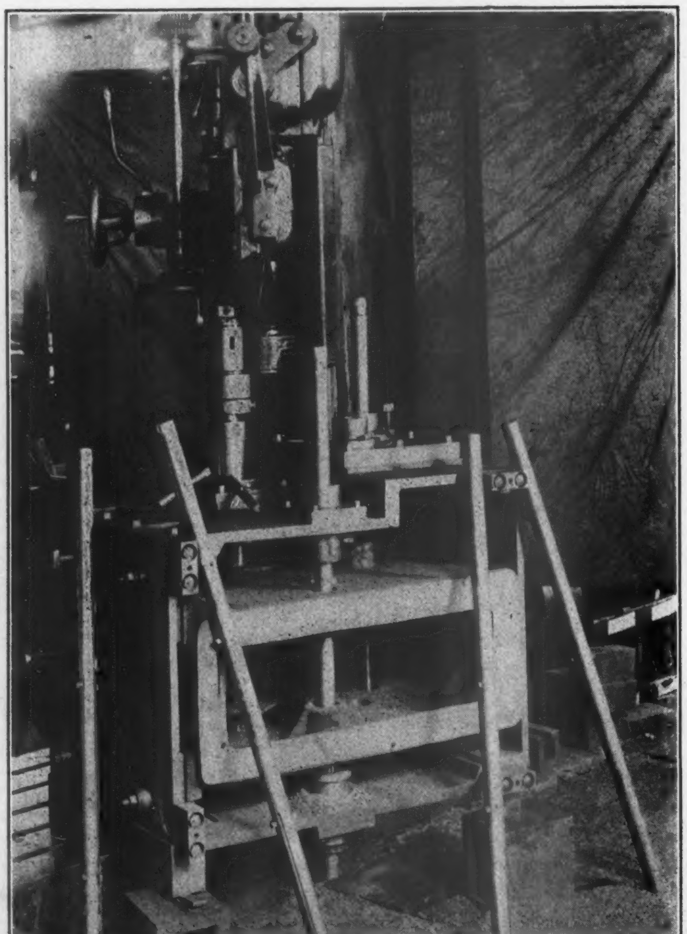


FIG. 1.—BORING JIG FOR SHAPER COLUMNS.

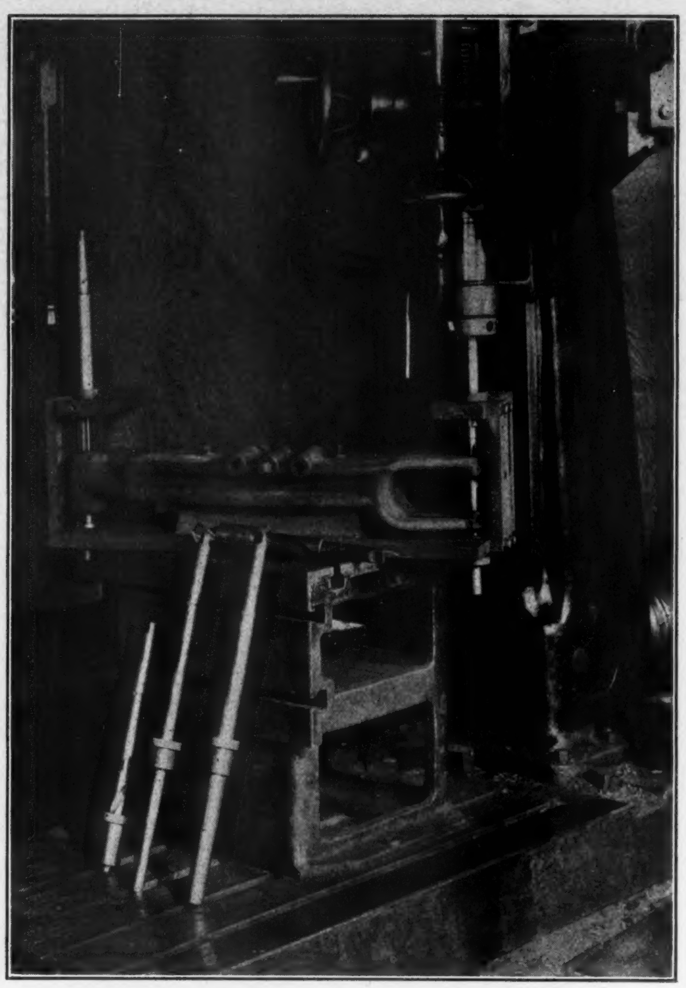


FIG. 2.—BORING JIG FOR ROCKER ARMS.

These points are thoroughly appreciated by most shaper manufacturers and the accompanying illustrations show some boring jigs which are used in the shops of the Queen City Machine Tool Company, Cincinnati, O., in order to obtain the very highest class of workmanship and perfect interchangeability in their crank shapers.

The illustration, Fig. 1, shows a boring jig for shaper columns, by means of which it is possible to get all the holes through the column in perfect alignment. The jig is of a full box pattern, both ends of the boring bar being supported. The bars have a universal joint connection to the driving spindle of the machine. Two cuts are taken in each case, the roughing cut leaving but a very thin film of metal to be removed by the finishing cut.

In Fig. 2 is shown a jig for boring and reaming the holes in the rocker arm, which must be at exact right angles to the sliding block bearing. The illustration shows the method of performing this work which turns out perfectly interchangeable rocker arms having all their bearings at exact right angles to the sliding surfaces.

These are but examples of the many jigs used in these shops, the value of which is proven by the high quality of the output.

RAILWAY GENERAL FOREMEN'S CONVENTION.

The annual convention of the International Railway General Foremen's Association, will be held at Chicago, June 1 to 5. The Lexington Hotel has been chosen as the official headquarters. Arrangements have been made for exhibits by the supply firms, particulars of which can be secured from the secretary of the supply men's association, J. Will Johnson, 1427 Monnadnock block, Chicago. E. C. Cook, Royal Insurance Building, Chicago, is secretary of the foremen's association.

RAILWAY APPLIANCES EXHIBITION.

An exhibition of all appliances used in the construction, maintenance and operation of railways will be held on a large scale at the Coliseum, Chicago, the week of March 15-20, inclusive. The appliances exhibited will be full size and many of them will be in operation.

For a number of years, The Road and Track Supply Association has had a small exhibit of models and drawings of these appliances in the parlors of the Auditorium Hotel during the annual meeting of the American Railway Engineering and Maintenance of Way Association. As railway officials naturally prefer to see the devices themselves, it was decided to give an exhibition that would comport in size and importance with the importance of the engineering and maintenance departments of American railways.

The Coliseum, which has been chosen for this purpose, has on the main floor 45,317 square feet, of which 32,517 square feet will be devoted to exhibits and 12,800 to aisles. In addition to this, there is an annex containing 9,582 square feet, 6,138 square feet of which will be devoted to exhibits. It will be the largest and most complete exhibit of materials for the engineering department that has ever been held in this country. It is expected that a very large number of railway officials will be in attendance, as it will be an opportunity of seeing the improvements made in the different devices, in which they are interested and that they could use to advantage.

That the manufacturers have shown great interest and taken advantage of this opportunity to show their product is evidenced by the large spaces that some of them have taken. Two firms have secured upwards of 1,500 square feet each, several 1,000 square feet each, and others sufficient space to show their devices.

Space at this exhibition can be secured from John N. Reynolds, Secretary-Treasurer, 160 Harrison street, Chicago.

BOOKS.

The Internal Combustion Engine. By H. E. Wimperis. 5½ x 8½. Cloth. 320 pages. Illustrated. Published by D. Van Nostrand Co., 23 Murray St., New York. Price, $3.00.

This book was written as a text-book on gas, oil and petrol engines for the use of students and engineers. It is a very complete and thorough technical work on internal combustion engines and gas producers, very completely illustrated, and will prove to be a very valuable book for the gas engineer.

High Steam Pressure in Locomotive Service. By W. F. M. Goss. Bulletin No. 26 of the Engineering Experimental Station, University of Illinois. Published at Urbana, Ill.

This bulletin is a review of the report to the Carnegie Institution of Washington on the subject of high steam pressure in locomotive service and was given in practically its present form on page 13 of the January, 1907, issue of this journal.

General Lectures on Electrical Engineering. By Charles P. Steinmetz. 275 pages. 6 x 9. Cloth. 48 diagrams. Published by Robson & Adee, Schenectady, N. Y. Price, $2.00.

The lectures forming this book were delivered to a class of young engineers, consisting mainly of college graduates, during the winter of 1907-08, by Dr. Steinmetz. The book includes 17 lectures in which the use of mathematics has been avoided. They give a broad review of the entire field of electrical power generation, transmission, distribution, control and use, and comprise a thorough discussion of the different methods of application of electric energy; the means and apparatus available; the different methods of carrying out the purposes and the advantages and disadvantages of the different methods,, and apparatus. The matter, while of a very high character, is given in simple language and is thoroughly illustrated by line diagrams. Practically all of the important branches of electrical engineering are considered. An excellent colored photograph of Dr. Steinmetz forms the frontispiece of the work.

PERSONALS.

J. A. Mellon, mechanical engineer of the Delaware, Lackawanna & Western Ry. at Scranton, Pa., has resigned.

W. S. Kenyon has been appointed master mechanic of the Missouri Pacific Ry., at Ferriday, La., succeeding Mr. Peasley.

George W. Kaiser, formerly assistant master mechanic of the Juniata shops of the Pennsylvania R. R., died at his home in New York recently.

E. G. Osgood has been appointed master mechanic of the Williamsville, Greenville & St. Louis Ry., succeeding O. D. Greenwalt, resigned.

J. C. Garden has been appointed master mechanic of the eastern division of the Grand Trunk Ry., with office at Montreal, succeeding T. McHattie.

W. H. Edgecombe has been appointed bonus supervisor of the western grand division of the Atchison, Topeka & Santa Fe Ry., with office at La Junta, Col.

T. McHattie, master mechanic of the Grand Trunk Ry. at Montreal, Que., has been appointed superintendent of motive power of the Central of Vermont.

B. J. Peasley, master mechanic of the Missouri Pacific Ry. at Ferriday, La., has been appointed master mechanic at De Soto, Mo., succeeding P. J. Conrath, resigned.

F. C. Pickard, master mechanic of the Mississippi Central Ry., has been appointed master mechanic of the Cincinnati, Hamilton & Dayton Ry. at Indianapolis, Ind., succeeding C. B. Cramer, resigned.

A. L. Kendall, general foreman of car shops of the New York Central & Hudson River R. R., at West Albany, has resigned to become general salesman for the W. P. Taylor Company, Buffalo, N. Y.

W. H. Dunlap, general foreman of the South Louisville shops of the Louisville and Nashville R. R., has been promoted to master mechanic at Covington, succeeding William Adair, who retires on a pension.

T. L. Burton has been appointed general inspector in charge of air brake, steam heat and car lighting equipment of the Philadelphia & Reading Ry., and will also perform such other duties as may be assigned to him.

R. G. Cullivan, general foreman, locomotive department, of the New York Central & Hudson River R. R., at West Albany, N. Y., has been appointed division superintendent of motive power at West Albany, succeeding E. A. Walton.

J. E. Irwin, master mechanic of the Marietta, Columbus & Cleveland Ry., has resigned to become superintendent of equipment of the Indian Refining Co., Georgetown, Ky., and Lawrenceville, Ind., and the position of master mechanic has been abolished.

Louis C. Fritch, assistant to the president of the Illinois Central R. R., has been appointed consulting engineer, in charge of electrification work, of the Illinois Central Ry., the Indianapolis

Southern and the Yazoo & Mississippi Valley, with office at Chicago.

G. I. Evans, chief draughtsman, is performing the duties of mechanical engineer of the Canadian Pacific Ry., with headquarters at Montreal.

S. S. Riegel has been appointed mechanical engineer of the Delaware, Lackawanna & Western R. R., with office as Scranton, Pa., vice J. A. Mellon, resigned. Mr. Riegel was formerly chief draughtsman of the Southern Railway and lately an engineer with the American Locomotive Company at Schenectady.

T. S. Reilly, who was appointed superintendent of motive power of the Canton Hankow Railway, at Canton, China, about a year ago, died suddenly from an abscess of the liver on January 30, 1909. He was 38 years of age at the time of his death. He graduated from the Pennsylvania Military College with the highest honors, and was well known among railway men in this country. His sudden death will be deeply regretted by his many friends.

Charles L. Gaspar, heretofore mechanical engineer on the Wisconsin Central Railway, has been appointed superintendent of motive power of the Canton Hankow Railway of China. Mr. Gaspar is a native of Wisconsin, and received his technical education at the Universites of Wisconsin and Purdue. He became special apprentice in the shops of the Wisconsin Central Railway in August, 1899, and in 1902 was employed as machinist on the same ground. From 1902 to 1903 he was chief draftsman, from which position he was promoted to that of mechanical engineer in 1904.

CATALOGS

IN WRITING FOR THESE PLEASE MENTION THIS JOURNAL.

ELECTRIC PUMP GOVERNORS.—The Westinghouse Traction Brake Company is issuing instruction pamphlet No. T-1542 on the subject of electric pump governors, giving full instructions for the operation and maintenance of these instruments.

CALENDARS RECEIVED.—Among the many calendars received are a number deserving special mention, viz.: Dearborn Drug & Chemical Works, Chicago; Falls Hollow Staybolt Co., Cuyahoga Falls, Ohio; Revere Rubber Co., Bostan, Mass., the Rodger Ballast Car Co., Chicago, and the American Tool Werks Co., Cincinnati, Ohio.

PAINTS FOR METAL.—The National Paint Works, Williamsport, Pa., is issuing the seventh edition of a paper entitled, "The Review of Technical Paints for Metals," by Frank Cheeseman. This paper considers this important subject very carefully and contains many valuable pointers.

OIL VS. COAL.—Tate Jones & Co., Pittsburgh, Pa., is issuing a very attractive illustrated booklet largely given up to a synopsis of the fuel oil equipment in use at the Jacksonville shops of the Seaboard Air Line; the Fort Wayne Shops of the Pennsylvania Railroad and the Westinghouse Air Brake Company's plant.

LOCOMOTIVE VALVES.—The American Balanced Valve Co., Jersey Shore, Pa., is issuing booklet No. 28, designed for information and convenience in ordering repair parts for valves manufactured by it. Each separate part of the different valves is illustrated and a convenient system of numbering is employed for identifying the parts.

EMERY AND CORUNDUM WHEELS.—The American Emery Wheel Works, 176 Fulton street, New York, is issuing a standard size, 83-page catalog, illustrating a great variety of emery, corundum, adamite, vitrified and silicate grinding wheels. The catalog includes list prices in each case, and, in addition to wheels, abrasives in other forms are shown.

SHAPERS.—Gould & Eberhardt, Newark, N. J., is issuing the 1909 edition of its catalog on high duty shapers and attachments. This catalog shows several new features that have been introduced in these high class machines during the past two years and very attractively illustrates and describes the output of this company, which covers all types of shapers and attachments.

WESTINGHOUSE APPARATUS.—Among the recent bulletins being issued by the Westinghouse Electric & Mfg. Co. is one on mercury rectifier battery charging outfits, explaining the principle of operation and the construction of this device very clearly. A very attractive catalog is also being issued on the subject of fan motors; and small leaflets on small direct current generator sets and electric vacuum cleaners.

HARD WATER MADE SOFT.—The L. N. Booth Co., 136 Liberty street, New York, is issuing a booklet on the above subject, which points out the special advantages and many uses of the type F Booth water softener. The subject of the value of soft water is very fully covered.

GENERAL ELECTRIC CO.—Among the bulletins lately issued by this company are No. 4641, pointing out the advantages in the use of electricity in the lumber and woodworking industries, including a description of the plant of the Great Southern Lumber Co. No. 4643 covers the subject of direct current switchboard instruments, and No. 4640 is devoted to large transformers. A small catalog on fan motors is also being sent out.

BLUE PRINTING MACHINE.—Keuffel & Esser Co., Hoboken, N. J., is issuing a catalog that very completely illustrates and describes the Champion continuous blue printing machine, which offers many advantages in connection with high speed and improved quality in making blue prints. The tracings are fed in either with separate sheets or on a continuous roll of blue print paper on top of the paper and right side up, which permits the operator to be much more accurate in his work than is usually possible in this type of machine.

NOTES.

RITTER FOLDING DOOR COMPANY.—Thornton N. Motley has been appointed eastern agent of the above company, with office at 1571, No. 50 Church street, New York City.

RAILWAY BUSINESS ASSOCIATION.—Frank W. Noxon has been appointed secretary, succeeding G. M. Basford, who has completed his work with that organization and again taken up his duties as Assistant to the President of the American Locomotive Company.

FALLS HOLLOW STAYBOLT COMPANY.—William C. Ennis, formerly occupying official positions in the motive power department of various railways and of late connected with the American Locomotive Company, and now located at 543 Broadway, Paterson, N. J., has been appointed eastern traveling representative of the above company.

U. S. METALLIC PACKING COMPANY.—Harry Vissering, for the last ten years general sales agent of the above company, with office at Chicago, has resigned, owing to his large interests in other fields. This resignation also covers his position as superintendent of the American Locomotive Sander Company.

MONARCH STEEL CASTINGS COMPANY.—Alexander B. Wetmore will accept the position of sales manager of the above company, Detroit, Mich., on March 1st. Mr. Wetmore leaves a long period of service with the Detroit Lubricator Co. to take up the sales of the "Monarch" coupler and "Monarch" graduated draft gear, made by the Monarch corporation.

AJAX METAL COMPANY.—This company announces that the patent office has granted it a re-issue patent, which covers the process of making bearing metals by limiting the tin to 9 per cent. of the copper and thus permitting an almost indefinite increase of the lead above 20 per cent. This patent has been passed upon by the U. S. Circuit Court.

AMERICAN BLOWER COMPANY.—Announcement has been made of the consolidation of the American Blower Company, of Detroit, and the Sirocco Engineering Company, of New York. The plants of both companies will continue in full operation and the business will, hereafter be transacted under the name of the American Blower Company, with principal offices at Detroit, Mich.

J. ROGERS FLANNERY & CO.—A selling company has been organized under the above name, with headquarters at Pittsburgh, Pa., to take over the sale of the Tate flexible staybolt, and also to exploit the Keystone nut lock. The representative of this company will be H. A.. Pike, New York; W. M. Wilson, Chicago; Grundy & Leahey, Richmond, Va., and Tom R. Davis, mechanical expert, Pittsburgh, Pa.

AMERICAN SPECIALTY COMPANY.—A contract has been closed between the American Specialty Company of Chicago and the High Speed Drill Company of Dubuque, Iowa, whereby the former takes the entire output of the latter and become exclusive sales agents for the complete line of Collis flat and flat twisted high speed drills. These drills have a standard taper shank, but can also be obtained with a straight shank.

STANDARD ROLLER BEARING CO.—This company announces that it has secured Henry Souther, a well-known engineer of Hartford, Conn., to devote a large part of his time to its interest as consulting engineer. Announcement is also made that the sales organization of the company has been extended by the appointment of F. M. Germane, formerly sales manager, as assistant general manager of the company; T. J. Heller has been appointed sales manager and F. W. Lawrence as western representative, the latter with headquarters at Chicago.

A STUDY OF THE NUMBER AND KIND OF MACHINE TOOLS REQUIRED IN A RAILWAY LOCOMOTIVE MACHINE AND BOILER SHOP.

L. R. POMEROY.

Editor's Note.—Mr. Pomeroy presents a most valuable and unique scheme for logically determining the kind and number of machine tools which may be required in a railroad shop to furnish a desired output. The usual method of basing the selection of tools for a new shop on the number and kind of tools used in an older shop, or in some other shop on the same road, or on other roads, is faulty and is little less than a "hit and miss" method. Improvements in railroad shop organization and operation, the rapid development of modern machine tools, and the increase in the size and the changes in design of locomotive parts make it necessary to consider each new shop by itself, and in detail. The idea of carefully investigating and studying each individual machine tool operation and basing the tool requirements upon the average time required for each operation and the average number of such operations in a given time is certainly a far more logical method than that usually followed. In these days when piece work and bonus systems are so generally used, making it possible to readily find the average time required for each individual operation, it should not be a difficult task to make such an analysis.

The Scranton shops of the Delaware, Lackawanna & Western Railroad are to have an ultimate capacity for building and repairing the following number of standard consolidation locomotives per month:

30 General Repairs.
8 Light Repairs.
4 New Locomotives.

The analysis, in tabular form on the following pages, considers each machine tool operation to be performed in the machine and boiler shops each month for the four new locomotives complete, and also the average number of operations to be performed for renewing or repairing the necessary parts for the engines receiving heavy and light repairs. Knowing the number of operations which must be performed each month and the average time required for each it is a simple matter to arrange the data as shown and to select the proper tools for doing the work.

Not only is it possible to determine the number and kind of tools required, but the study automatically indicates the proper grouping of the machines to promote a logical and proper sequence of operations, as will be apparent from a study of the tabulated data.

Knowing the tools which are necessary for the maximum output, a selection may readily be made of those necessary to meet a predetermined minimum condition, such as will prevail when the shop is first opened; at the same time the groups may be arranged to admit of tools being added from time to time, leading up to the maximum requirements. In this way the original scheme may be carried out without in any way interfering with the shop efficiency conducted on a minimum basis.

As the basis for the tabulation, the heaviest standard road engine was used. This is a 2-8-0 type with an anthracite burning, Wooten-type boiler and separate engineer's and firemen's cabs, the former being located ahead of the firebox. It has 21x32-inch cylinders, 55-inch driving wheels, and weighs 177,000 pounds on drivers, with a total weight of 200,000 pounds. It was thought that by using the largest standard locomotive as a basis, rather than the average, the figures would be more conservative.

On some details, where it might prove more difficult to predetermine the amount of work necessary to true up worn parts, etc. (*i. e.*, on a repair basis), a percentage has been used, based on manufacturing conditions for similar parts for new engines. In the column showing the number of repair parts to be machined each month the parts for both heavy and light repairs are included, although from the way in which they are derived it might appear that they referred to the heavy repairs only.

The use of the largest standard engine and the percentages used to determine the average work for repairs, have been considered as leaving enough margin to amply provide for contingencies, and also to provide for such manufacturing for other divisions of the road as is deemed wise: this is considered the main shop of the system and has a foundry and other facilities not possessed by the division shops.

A great deal has been done in the way of standardizing patterns, scaling them down very closely to finished sizes; such forgings as crank pins and piston rods are purchased rough-turned to within 1-16-inch of the finished size, and driving and truck axles are received within ⅛-inch of the finished size; the rough-turning is done with a flat nosed tool and therefore the amount of metal to be removed on such parts is reduced to a minimum.

The driving power for each machine and the method of driving, whether group or individual drive, is to be determined by the actual service requirements and the relation of the particular tool to the whole or local department, on the basis of an expected maximum amount of metal to be removed. Consequently it is safe to assume that a favorable load factor can be realized.

A STUDY OF THE MACHINE TOOL OPERATIONS REQUIRED IN A RAILROAD LOCOMOTIVE MACHINE SHOP, FOR MAKING REPAIRS TO AND BUILDING THE FOLLOWING NUMBER OF CONSOLIDATION LOCOMOTIVES PER MONTH, THE SHOP OPERATING EIGHT HOURS PER DAY:—30 GENERAL REPAIRS, 8 LIGHT REPAIRS, AND FOUR NEW LOCOMOTIVES.

Class of Work	Machine Tool	Operation	Number of Pieces per Month: New Engs.	Repairs	Total	Average Time per Piece	Total Days Work per Month	
Driving Wheels and Tires	1 80" Driving Wheel Lathe	Turning Tires		4x8 [1] and 30x4 [2]	152 [3]	1½ hrs. [4]	28½	1 mach.
	1 Driving Wheel Lathe	Trueing Journals		152x50%	76 [3]	2½ hrs. [4]	24	1 mach.
	1 7' Vertical Boring Mill	Boring Tires	4x8=32	30x8x15%=36	68	40 min.	5⅔	1 mach. [6]
		Smoke Arch Rings	4x1=4	30x1x10%= 3	7	2½ hrs.	2¼	
	1 400 Ton Wheel Press							1 mach.
	1 Quartering Machine	Quartering Wheels	4x4=16	30x4x10%=12	28	3 hrs.	10½	1 mach.
	2 Ver. Boring Mills, 6 and 7 ft.	Wheel Centers	4x8=32	30x8x10%=24	56	8 hrs.	56	2 mach. [7]
Frames	1 Planer, 36"x15', 4 Heads	Front Rails	4x4=16	30x4x10%=12	28	4 hrs.	14	1 mach.
	1 Frame Planer, 72"x32'	Main Frames (2 Per Setting)	4x2= 8	30x2x10%= 6	14	8 hrs. [5]	14	1 mach.
	1 Three-Head Frame Slotter	Slot (4 Per Setting)	4x2= 8	30x2x10%= 6	14	15 hrs. [5]	26¼	1 mach.
	1 Frame Drill, 4 Head	Drill and Ream	4x2= 8	30x2x10%= 6	14	15 hrs. [5]	26¼	1 mach.
Axles	1 Lathe, 32"x14'	Driving Axles	4x4=16	30x4x50%=60	76	3 hrs.	29½	1 mach.
	1 Double Keyway Cutter	Cutting Keyways	4x4=16	30x4x50%=60	76	1 hr.	9½	1 mach.
	1 Lathe, 26"x14'	Engine Truck Axles	4x1= 4	30x1x50%=15	19	2¼ hrs.	5⅓	1 mach.
	1 D. H. Axle Lathe	Tender Truck Axles	4x4=16	30x4x60%=72	88	45 min.	8¼	1 mach.
Rods	1 Slab Miller, 48"x16'	Rods	4x8=32	30x8x10%=24	56	6 hrs.	42	1 mach.
	1 Vertical Miller, 42"	Mill Hubs	4x6=24	30x6x10%=18	42	5 hrs.	26¼	1 mach.
	1 D. H. Rod Borer	Rods	4x6=24	30x6x10%=18	42	2 hrs.	10½	1 mach.
	1 Ver. Drill, 44", Comp. Table	Rods and Straps				4½ hrs.	31½	1 mach.
	1 Slotter, 10"; 1 Slotter, 12"	Valve Yokes	4x2= 8	30x2x50%=30	38	2 hrs.	9½	43½ days 2 mach.
		Main Rod Straps, Back End			17	5¾ hrs.	33¾	
		Main Rod Straps, Front End			17			
		Main Connecting Rod Straps			17			
		Main Connecting Rod Knuckle Fit			6			
		Rods to Length			24			
	1 Planer, 36"x8', 4-Head; 1 Planer, 30"x12'	Straps, New			41	1½ hr.	7¾	52½ days 2 mach.
		Rods, New			56	3¼ hrs.	22¾	
		Rods, Old			15	1¼ hr.	2¼	
		Back Cyl. Heads	4x2= 8	30x2x15%= 9	17	9 hrs.	19⅛	
	1 Lathe, 16"x8'	Knuckle Pins	4x4=16	30x4=120	136	30 min.	8	24½ days 1 mach.
		Knuckle Pin Bushings	4x4=16	30x4=120	136	30 min.	8	
		Wrist Pins	4x2= 8	30x2= 60	68	1 hr.	8½	
	1 Hyd. Press, 25 Ton	Bushings						1 mach.
Crank Pins	1 Lathe, 26"x10'	Crank Pins	4x8=32	30x8x10%=24	56	3½ hrs. [9]	24½	1 mach.
	1 Vertical Drill, 36"	Crank Pins	4x6=24	30x6x10%=18	42	2½ hrs.	13⅛	22 days 1 mach.
		Guide Bars	4x4=16	30x4x30%=36	52	49 min.	5⅓	
		Guide Blocks	4x4=16	30x4x30%=36	52	12 min.	1⅓	
		Crossheads	4x2= 8	30x2x15%= 9	17	15 min.	½	
		New Crosshead Shoes [10]		30x2x25%=15	15	1 hr.	1⅞	
Driving Boxes	1 Planer, 42"x20'; 1 Planer, 42"x12'	Boxes	4x8=32	30x8x10%=24	56	3¼ hr.	22¾	2 mach.
		Old Boxes		30x8x90%=216	216	54 min.	24	
	1 Ver. Rapid Production Lathe, 37" (Bullard)	Face New Boxes	4x8=32	30x8x10%=24	56	1⅓ hr.	9⅓	28 days 1 mach.
		Turn Brass for Box Fit	4x8=32	30x8x90%=216	248	20 min.	10⅓	
		Bore Ecc. Crank (Walschaert)	4x2= 8	30x2x 5%= 3	11	2 hrs.	2¾	
		Piston Valve Cyl. Heads	4x4=16	30x4x 5%= 6	22	2 hrs.	5½	
	1 Draw Shaper, Morton	Shape for Brass and Cellar Fit	4x8=32	30x8x10%=24	56	3¼ hrs.	22¾	1 mach.
	1 Ver. Boring Mill, 37"	Bore Brass and Face Box	4x8=32	30x8=240	272	44 min.	25	1 mach.
	1 Crank Planer, 20"x20"x24"	Cellars	4x8=32	30x8x20%=48	80	30 min.	5	34½ days [12] 1 mach.
		Brasses	4x8=32	30x8x90%=216	248	20 min.	10⅓	
		Rod and Eccentric Keys	4x8=32	30x8x40%=96	128	25 min.	6⅔	
		Frame Keys	4x16=64	30x16x50%=240	304	20 min.	12⅔	
	1 Radial Drill, 3'	Boxes	4x8=32	30x8x10%=24	56	2¼ hrs.	16	1 mach.
		Old Boxes		30x8x90%=216	216	30 min.	13½	
Cylinders and Heads	1 Cylinder Boring Mill	Bore Cyls	4x2= 8	30x2x10%= 6	14	8 hrs.	14	1 mach.
	1 Cylinder Planer, 72"x12'	Plane Cyls	4x2= 8	30x2x10%= 6	14	15 hrs.	26¼	1 mach.
	1 Port Miller	Mill Ports						1 mach.
	1 Radial Drill, 5'	Cylinders	4x2= 8	30x2x10%= 6	14	6½ hrs.	11⅜	1 mach.
		Wheel Centers	4x8=32	30x8x10%=24	56	40 min.	4⅔	
		Front Frame Rails	4x4=16	30x4x10%=12	28	4 hrs.	14	
	1 Ver. Boring Mill, 42"	Piston Packing Rings	4x6=24	38x6=228	252	20 min.	10½	22⅔ days 1 mach.
		Front Cylinder Heads	4x2= 8	30x2x30%=18	26	68 min.	3⅔	
		Back Cylinder Heads	4x2= 8	30x2x15%= 9	17	4 hrs.	8½	
	1 Ver. Rapid Production Lathe, 37" Bullard	Piston Valve Bushing		30x4x25%=30	30	4 hrs.	15	1 mach.
		Piston Valve Packing Rings		30x8x50%=120	120	20 min.	5	
	1 Radial Drill, 3'	Front Cyl. Head	4x2= 8	30x2x30%=18	26	84 min.	4½	23¾ days 1 mach.
		Back Cyl. Head	4x2= 8	30x2x15%= 9	17	2 hrs.	4¼	
		Piston Valve Bushing		30x4x20%=30	30	4 hrs.	15	
Piston Rods	1 Lathe, 26"x12'	Piston Rods	4x2= 8	30x2x60%=36	44	4 hrs.	22	1 mach.
	1 Gap Grinder, Norton	Piston Rods	4x2= 8	30x2x60%=36; 30x2x40%=24	68	40 min.	5⅔	1 mach. [11]
	1 Cottering Machine	Keyways	.....	.....	.....	.....	.....	1 mach.
Guides	1 Plain Hor. Miller, 20"x8'	Guides	4x4=16	30x4x30%= 36	52	4 hrs.	26	36½ days 1 mach.
		Old Guides		30x4x70%= 84	84	1 hr.	10½	
	1 Guide Bar Grinder, 80"	Guides	4x4=16	30x4=120	136	30 min.	8½	1 mach.
	1 Shaper, 16"	Cut to Length, Cut Clearance	4x4=16	30x4x30%= 36	52	1 hr.	6½	18¼ days 1 mach.
		Old Guides, Cut Clearance		30x4x70%= 84	84	30 min.	5¼	
		Guide Blocks	4x4=16	30x4x20%= 24	40	35 min.	3	
		Frame Keys	4x8=32	30x8x10%= 24	56	30 min.	3½	
	1 Lathe, 16"x8'	Guide Blocks	4x4=16	30x4x20%= 24	40	1 hr.	5	19¼ days 1 mach.
		Crank Pin Collars	4x8=32	30x8x50%=120	152	40 min.	12⅔	
		Wrist Pin Washers	4x2= 8	30x2x30%= 18	26	30 min.	1⅝	
Crossheads	1 Planer, 30"x10'	Crossheads	4x2= 8	30x2x15%= 9	17	4 hrs.	8½	22 days 1 mach.
		Crossheads, Old		30x2x85%= 51	51	90 min.	9½	
		Block and Gibs, Old Crossheads		30x4x20%= 24	24	72 min.	3⅝	
	1 Horizontal Boring Mill 4" Spindle, 6' Table	Bore and Ream for Piston Rod Fit	4x2= 8	30x2x15%= 9	17	2 hrs.	4¼	18⅞ days 1 mach.
		Ream Old Heads		30x2x15%= 10	10	1 hr.	1¼	
		Rebore Air Pump Cyl.		30x2x50%= 30	30	1 hr.	3¾	
		Bore Steam Chests	4x2= 8	30x2x30%= 18	26	1 hr.	3¼	
		Bore and Make Joints, Throttle Box	4x1= 4	30x1x20%= 6	10	3 hrs.	3¾	
		Rebore Old Throttle Box		30x1x50%= 15	15	1 hr.	1⅞	

[1] Light Repairs. [2] Heavy Repairs. [3] Pairs. [4] Per Pair. [5] Per Frame. [6] Balance of Time Available for Wheel Centers. [7] See Previous Note. [8] Available for Driving Axles. [9] Time required when main pins are rough turned. [10] Drilled for old crossheads. [11] Balance of time available for valve yokes, wrist pins, etc. [12] See shoes and wedges.

Class of Work	Machine Tool	Operation	Number of Pieces per Month: New Engs.	Repairs	Total	Average Time per Piece	Total Days Work per Month	
Steam Chests	1 Planer, 36"x10', D. H.	Steam Chests	4x2= 8	30x2x30%= 18	26	3 hrs.	9¾	20⅛ days 1 mach.
		Steam Chest Covers and Pressure Plates	4x2= 8	30x2x30%= 18	26	2½ hrs.	8⅛	
		Steam Chests, Old		30x2x30%= 18	18	1 hr.	2¼	
		Bore Stuffing Box [6]						
	1 Radial Drill, 3'	Drill Steam Chests and Tap	4x2= 8	30x2x30%= 18	26	1 hr.	3¼	22⅞ days 1 mach.
		Steam Chest Covers	4x2= 8	30x2x30%= 18	26	2 hrs.	6½	
		Pressure Plates	4x2= 8	30x2x30%= 18	26	30 min.	1⅝	
		Piston Valve Cyl. Head	4x4=16	30x4x 7%= 8	24	1 hr.	3	
		Drill and Tap Piston Heads	4x2= 8	30x2=60	68	1 hr.	8½	
Valves	1 Planer, 30"x10', D. H.	Valves	4x2= 8	30x2x50%= 30	38	4 hrs.	19	26 days 1 mach.
		Valve Yokes	4x2= 8	30x2x50%= 30	38	30 min.	2⅜	
		False Seats		30x2x25%= 15	15	2½ hrs.	4$\frac{11}{16}$	
	1 Plane Miller, 14"x6'	Valves	4x2= 8	30x2x50%= 30	38	2 hrs.	9½	24 days 1 mach.
		False Seats		30x2x25%= 15	15	2½ hrs.	4¾	
		Valve Strips	4x2= 8	30x2x75%= 44	52	1½ hrs.	9¾	
	1 Lathe, 20"x10' 1 Lathe, 24"x14'	Valve Yoke	4x2= 8	30x2x50%= 30	38	2 hrs.	9½	51½ days 2 mach.
		Piston Valves [8]		30x2x25%= 16	16	10 hrs. [8]	20	
		Piston Valve Stems [9]		30x2x25%= 16	16	7 hrs. [9]	14	
		Valve Rods	4x2= 8	30x2x15%= 8	16	4 hrs.	8	
Valve Gear	1 Lathe, 32"x12'	Lifting Shaft	4x1= 4	30x1x20%= 6	10	2½ hrs.	3⅛	24⅛ days 1 mach.
		Old Lifting Shaft		30x2x25%= 15	15	40 min.	1¼	
		Rocker Arms	4x2= 8	30x2x15%= 9	17	4 hrs.	8½	
		Old Rocker Arms		30x2x50%= 30	30	1 hr.	3¾	
		Walschaert Link Saddles	4x4=16	30x4x 5%= 6	22	2 hrs.	5½	
		Drill, Ream, Turn Valve Rod (Wals.)	4x2= 8	30x2x 5%= 3	11	1½ hrs.	2	
	3 Lathes, 18", 18" and 16"	Pins (34 Locos)	...	...	800	45 min.	75	3 mach.
	1 Centering Machine, 14"	For Center Pins	...	...	...	...	...	1 mach.
	1 W. S. Turret Lathe, 3"x 36"	Rocker Box Bolts [7]	...	...	...	...	...	1 mach.
	1 Rapid Production Ver. Lathe, 37", Bullard	Bore and Turn Ecc. Cams	4x4=16	30x4x50%= 60	76	1½ hr.	14¼	25¾ days 1 mach.
		Bore Ecc. Straps	4x4=16	30x4x50%= 60	76	1 hr.	9½	
		Rebore Old Ecc. Straps		30x4x20%= 24	24	40 min.	2	
	1 Horizontal Boring Mill, 4" Spindle, 6' Table	Rocker Boxes	4x2= 8	30x2x10%= 6	14	2 hrs.	3½	19 days 1 mach.
		Bore for Bushing		30x2x10%= 6	6	2 hrs.	1½	
		Bushed Boxes		30x2x60%= 36	36	1¼ hrs.	5⅝	
		Valve Guide Crosshead	4x2= 8	30x2x20%= 12	20	40 min.	1⅔	
		Lift Shaft Boxes	4x2= 8	30x2x30%= 18	26	45 min.	2⅜	
		Trans. Bar Hangers		30x2x10%= 6	6	1 hr.	¾	
		Link Brackets (Wals.)	4x2= 8	30x2x 5%= 3	11	2½ hrs.	3⅜	
	2 Planers, 30"x10'	Eccentric Cams	4x4=16	30x4x50%= 60	76	1 hr.	9½	35¼ days 2 mach.
		Link Bracket (Wals.)	4x2= 8	30x2x 5%= 3	11	2 hrs.	2¾	
		Rocker Boxes	4x2= 8	30x2x20%= 12	20	3 hrs.	7½	
		Link Saddle (Wals.)	4x4=16	30x4x 5%= 6	22	3 hrs.	8¼	
		Links	4x2= 8	30x2x10%= 6	14	2½ hrs.	4⅜	
		Union Lever Bracket	4x2= 8	30x2x 5%= 3	11	1 hr.	1⅜	
		Transmission Bar		30x2x10%= 6	6	2 hrs.	1½	
	1 Horizontal Milling Mach. 30"x10' (for Walschaert Valve Gear)	Comb. Levers	4x2= 8	30x2x 5%= 3	11	3 hrs.	4⅛	25¼ days 1 mach.
		Radius Bar	4x2= 8	30x2x 5%= 3	11	5 hrs.	6⅞	
		Eccentric Rod	4x2= 8	30x2x 5%= 3	11	6 hrs.	8¼	
		Guide Bar	4x2= 8	30x2x 5%= 3	11	2 hrs.	2¾	
		Reverse Lever	4x1= 4	30x1x20%= 6	10	1½ hrs.	1⅞	
		Reverse Lever Quadrant	4x1= 4	30x1x20%= 6	10	1 hr.	1¼	
	1 Vertical Miller, 42" 1 Vertical Miller, 33"	Links	4x2= 8	30x2x10%= 6	14	6 hrs.	10½	78¾ days 2 mach.
		Combination Lever	4x2= 8	30x2x 5%= 3	11	10 hrs.	13¾	
		Radius Bar	4x2= 8	30x2x 5%= 3	11	12 hrs.	16½	
		Eccentric Rod	4x2= 8	30x2x 5%= 3	11	1 hr.	1⅜	
		Union Bar	4x2= 8	30x2x 5%= 3	11	3 hrs.	4⅛	
		Union Bar Bracket	4x2= 8	30x2x 5%= 3	11	2 hrs.	2¾	
		Eccentric Jaws	4x4=16	30x4x25%= 30	46	2 hrs.	11½	
		Rocker Arms	4x2= 8	30x2x15%= 9	17	3½ hrs.	7⅜	
		Link Blocks	4x2= 8	30x2x10%= 6	14	1 hr.	1¾	
		Link Hangers	4x2= 8	30x2x10%= 6	14	3 hrs.	5¼	
		Link Saddles	4x2= 8	30x2x10%= 6	14	1½ hrs.	2⅝	
		Rod Keys	4x4=16	30x4x40%= 48	64	9 min.	1⅕	
	1 Plain Miller 14"x6'	Eccentric Straps	...	...	76	20 min.	3$\frac{1}{12}$	23⅓ days 1 mach.
		Union Bar	...	...	14	35 min.	1	
		Reverse Lever Latch	...	...	34	2 hrs.	8½	
		Valve Rod (Wals.)	...	...	14	1½ hrs.	2⅝	
		Cut Slot in Ecc. Crank	...	...	14	1 hr.	1¾	
		Throttle Latch	...	...	34	15 min.	1	
		Rev. Lever Latch Handle	...	...	34	12 min.	1	
		Throttle Lever Latch Handle	...	...	34	12 min.	1	
		Keyway in Lift Shaft	...	...	10	30 min.	⅝	
		Throttle Lever Quadrant	4x1= 4	30x20%=6	10	2 hrs.	2½	
	1 Slotter, 12"	Keyways in Ecc. Cams	...	...	76	20 min.	3⅛	25¼ days 1 mach.
		Keyway in Ecc. Crank	...	...	12	15 min.	⅜	
		Keyway in Lift Shaft Arm	...	...	10	15 min.	$\frac{5}{16}$	
		Ecc. Rod for Brass	...	...	11	2 min.	2¾	
		Clearance in Radius Bar	...	...	14	1½ min.	2⅝	
		Transmission Bars	...	...	6	3 min.	2¼	
		Clearance in Links	...	...	20	2 min.	5	
		Reverse Lever Quadrant	4x1= 4	30x20%=6	10	3 min.	3¾	
		Transmission Bars	...	...	20	2 min.	5	
	1 Crank Planer 20"x20"x 24"	Ecc. Straps for Blade Fit	...	...	76	25 min.	4	27 days 1 mach.
		Lifting Shaft Boxes	...	...	30	1 hr.	3¾	
		Valve Rod Guide Box (Wals.)	...	...	14	3 hrs.	6¼	
		Ecc. Blades for Strap Fit and Jaw Faces	...	...	36	30 min.	2¼	
		Link Saddles	...	30x2x20%=12	12	1 hr.	1½	
		Radius Bar Guide Box	...	...	14	2 hrs.	3½	
		Link Block	4x2= 8	30x2x10%=6	14	20 min.	⅝	
		Link Block Plates	...	...	88	20 min.	3⅝	
		Top of Transmission Hanger	...	...	20	30 min.	1¼	

[6] See Crossheads. [7] Also rough turn all motion pins, eccentric set bolts, bushings, etc. [8] This incudes two cast steel follower plates, two skeleton rings and one center piece. [9] This includes straightening, centering and all work from the rough forging.

Class of Work	Machine Tool	Operation	Number of Pieces per Month: New Engs.	Repairs	Total	Average Time per Piece	Total Days Work per Month	
Valve Gear (*Continued*)	1 Vertical Drill, 21"; 1 Vertical Drill, 26"; 1 Radial Drill, 5'	Lift Shaft Arms			10L.S.	1 hr.	1¼	87 days 3 mach.
		Rocker Arms			17	3 hrs.	6⅜	
		Eccentric Crank			11	2 hrs.	2¾	
		Piston Valve Cyl. Heads			30	1 hr.	3¾	
		Valve Guide Crosshead and Cap			14	1½ hr.	2⅝	
		Lifting Shaft Boxes			30	1½ hrs.	4⅝	
		Transmission Hangers			20	30 min.	1¼	
		Link Saddles			40	15 min.	1¼	
		Links			20	1½ hr.	3¾	
		Union Bar			11	1 hr.	1⅜	
		Crosshead Bracket			14	30 min.	⅞	
		Combination Lever			11	1½ hr.	2	
		Radius Bar			11	2 hrs.	2¾	
		Eccentric Rod			11	1½ hr.	2	
		Guide Bar (Wals.)			11	45 min.	1	
		Transmission Bar			6	2½ hrs.	1⅞	
		Reverse Lever			10	35 min.	¾	
		Reverse Lever Quadrant			10	15 min.	5/16	
		Eccentric Jaws			30	35 min.	2³⁄₁₆	
		Link Blocks			14	1 hr.	1¾	
		Throttle Latch			34	3 min.	¼	
		Throttle Latch Handle			34	6 min.	7/16	
		Rev. Lever Latch Handle			34	6 min.	7/16	
		Reverse Lever Latch			34	15 min.	1	
		Throttle Lever Quadrant			10	10 min.	¼	
		Radius Bar Guide Box			11	45 min.	1	
		Link Block Plates			88	12 min.	2⅛	
		Link Hangers			20	1¼ hrs.	3⅛	
		Reach Rod			20	40 min.	1⅝	
		Eccentric Straps			76	2 hrs.	19	
		Eccentric Cams			76	1 hr.	9½	
		Link Brackets			11	1 hr.	1⅜	
		Rocker Box			20	1 hr.	2½	
		Valve Rods		30x2x10%=6	6	20 min.	¼	
Pistons	1 Rapid Prod. Ver. Lathe, 37"	Bore and Turn Piston Head	4x2= 8	30x2=60	68	2 hrs.	17	1 mach.
	1 Rapid Production Vertical Lathe, 37"	Air Pump Packing Rings			120	8 min.	2	28⅜ days 1 mach.
		Piston Rod Glands	4x2= 8	30x2x35%=21	29	45 min.	2¾	
		U. S. Packing Cases			29	20 min.	1¼	
		Dome Caps	4x1= 4	30x10%=3	7	1⅓ hr.	1⅓	
		Auxiliary Domes	4x1= 4	30x10%=3	7	1⅓ hr.	1⅓	
		Hub Plates	4x8=32	30x8x30%=72	104	1¼ hr.	16¼	
		Air Pump Piston Heads		30x2x50%=30	30	1 hr.	3¾	
Engine and Tender Truck Work	1 Wheel Borer, 48"	Truck Wheels, Eng. and Ten.	4x10=40	11x30x60%=198	238	20 min.	10	1 mach.
	1 Wheel Lathe, Steel Tire 48"	Tires			165[3]	1 hr.	20⅝	1 mach.
	1 Planer, 48"x10'	Truck Center Casting	4x1= 4	30x25%=8	12	2 hrs.	1½	24 days 1 mach.
		Truck Cradle Brace	4x1= 4	30x50%=15	19	3 hrs.	7⅛	
		Truck Frames	4x1= 4	30x50%=15	19	2½ hrs.	6	
		Pedestals	4x4=16	30x6x50%=90	106	30 min.	6⅝	
		Binder Cstg., Tender Truck	4x1= 4	30x4x20%=24	28	45 min.	2⅝	
	2 Drill Press, 20" and 26"; 2 Radial Drill, 3' and 4'	Eng. Trucks	4x1= 4	30x50%=15	19	13 hrs.	31	95 days 4 mach.
		Tender Trucks	4x2= 8	30x2x40%=24	32	16 hrs.	64	
	1 Shaper, 20"	Col. Cstg., Ten. Truck	4x8=32	30x8x25%=60	92	1½ hr.	17¼	30⅓ days 1 mach.
		Eng. Truck Brasses	4x2= 8	30x3x30%=27	35	20 min.	1½	
		Hanger Brackets, Brake	4x4=16	30x4x20%=24	40	1 hr.	5	
		Filling Blocks	4x2= 8	30x2x10%=6	14	1 hr.	1¾	
		Spring Saddles	4x6=24	30x6x50%=90	114	20 min.	4¾	
	1 200-Ton Wheel Press							1 mach.
Shoes and Wedges	2 Planers, 36"x12', 30"x12'	Shoes and Wedges	4x16=64	30x16=480	544	35 min.	39	2 mach.
	1 Crank Planer, 20"x20"x24"	Shoes and Plane to Line			544	15 min.	17	1 mach.
	6	Drill for Set Bolts						
Throttle Rigging	1 Lathe, 32"x12'; 1 Lathe, 18"x8'	See Crossheads for Hor. Bor. Mill						40 days 2 mach.
		Dry Pipes	4x1= 4	30x20%=6	10	2 hrs.	2½	
		Dry Pipe Sleeves	4x2= 8	30x2x20%=12	20	2 hrs.	5	
		Throttle Valves	4x1= 4	30x50%=15	19	3 hrs.	7⅛	
		Steam Pipe Joint Rings	4x5=20	30x5x35%=50	70	1 hr.	8¾	
		Stand Pipes	4x1= 4	30x20%=6	10	1 hr.	1¼	
		Old Stand Pipes, Trued			24	30 min.	1½	
		Throttle Valve Shafts	4x1= 4	30x20%=6	10	1 hr.	1¼	
		Throttle Valve Stems	4x1= 4	30x50%=15	19	30 min.	1¼	
		Dome Caps	4x1= 4	30x20%=6	10	4 hrs.	5	
		Exhaust Pipes	4x1= 4	30x50%=15	19	1½ hr.	3½	
		Exhaust Nozzle Tips	4x2= 8	30x2x40%=24	32	40 min.	2⅔	
		Dry Pipe and Sleeves	4x2= 8	30x2x20%=12	20	40 min.	1⅔	
		Standpipe U Bolt, Drill and Tap	4x1= 4	30x1=30	34	20 min.	1½	
		Front End Draw Casting	4x1= 4	30x1x65%=20	24	1 hr.	3	
		Standpipe Brace	4x1= 4	30x50%=15	19	15 min.	⅝	
		Throttle Stuffing Box and Gland	4x1= 4	30x20%=6	10	20 min.	⅜	
	1 Radial Drill, 3'	Reversing Mechanism[7]	4x1= 4	30x20%=6	10	2⅜ hrs.	3	26½ days 1 mach.
		Dome Caps	4x1= 4	30x20%=6	10	1 hr.	1¼	
		Auxiliary Domes	4x1= 4	30x20%=6	10	1 hr.	1¼	
		Tee Heads	4x1= 4	30x20%=6	10	1¼ hr.	1½	
		Steam Pipes	4x2= 8	30x2x40%=24	32	2 hrs.	8	
		Exhaust Pipes	4x1= 4	30x50%=15	19	1 hr.	2⅜	
		Exhaust Pipe Shield	4x1= 4	30x50%=15	19	10 min,	⅜	
		Main Brace for Pilot	4x1= 4	30x1x65%=20	24	30 min.	1½	
Pilot and Miscellaneous Work	1 Vertical Drill, 22"	Bottom Frames	4x1= 4	30x65%=20	24	1 hr.	3	26½ days 1 mach.
		Top Rails	4x1= 4	30x65%=20	24	1 hr.	3	
		Corner Uprights	4x2= 8	30x2x65%=40	48	15 min.	1½	
		Smoke Arch Braces	4x2= 8	30x2x50%=30	38	30 min.	2⅜	
		Bumper Beam Castings	4x2= 8	30x2x50%=30	38	2 hrs.	9½	
		Driving Box Cellars		30x8x20%=48	48	15 min.	1½	
		Shoes and Wedges	4x16=64	30x16=480	544	3⅓ min.	3¾	
		Piston Rod Packing Glands	4x2= 8	30x2x35%=21	29	20 min.	1¼	
		Valve Stem Packing Glands	4x2= 8	30x2x35%=21	29	15 min.	1	
Spring and Brake Rigging	1 Radial Drill, 3'; 2 Ver. Drills, 25" and 40"	Spring Rigging	4x1= 4	30x75%=22	26	9 hrs.	29¼	87¾ days 3 mach.
		Brake Rigging	4x1= 4	30x75%=22	26	18 hrs.	58	

[3] Pairs. [6] See Driving Boxes. [7] Levers, crank, shaft and arms, quadrant, quadrant brackets, latch, latch lifter and reach rod.

Class of Work	Machine Tool	Operation	Number of Pieces per Month: New Engs.	Number of Pieces per Month: Repairs	Number of Pieces per Month: Total	Average Time per Piece	Total Days Work per Month	
Brass Work	1 Lathe, 16"x8'	Piston and Valve Stem Packing	4x4=16	30x4=120	136	1½ hr.	25½	1 mach.
		Tank Valves	4x2= 8	30x2x60%=36	44	40 min.	3⅔	
		Throttle Stuffing Box and Gland	4x1= 4	30x20%=6	10	2 hrs.	2½	
	1 Lathe, 18"x10'	Turn Rocker Bushing	.....	.....	96	20 min.	4	21 days 1 mach.
		Bells	4x1= 4	30x10%=3	7	3½ hrs.	3	
		Whistles	4x1= 4	30x20%=6	10	4 hrs.	5	
		Tank Hose Nuts and Connections	.....	.....	68	20 min.	2⅚	
		Hub Liner Bolts	.....	128x8=1,024	1024	4 min.	8	
		Boiler Plugs	4x10=40	30x10x50%=150	190	4 min.	1 7/12	
	1 Lathe, 14"x6'	Driving Box Plugs	4x8=32	30x8=240	272	7 min.	4	26½ days 1 mach.
		Muffler Valves Overhauled	.....	30x2=60	60	1 hr.	7½	
		Feed Pipe Sleeve	4x2= 8	30x2x50%=30	38	17 min.	1⅓	
		Valve Stems, etc.	.....	.....	.....	.....	4	
		Relief Valves	4x2= 8	30x2x50%=30	38	2 hrs.	9½	
		Relief Valves Overhauled	.....	30x2x50%=30	30	20 min.	1¼	
		Blow-off Cocks	4x1= 4	30x50%=15	19	2½ hrs.	7⅞	
		Blow-off Cocks Overhauled	.....	30x50%=15	15	30 min.	15/16	
		Water Glass Cocks	4x2= 8	30x2x50%=30	38	1⅔ hr.	8	
		Water Glass Cocks Overhauled	.....	30x2x50%=30	30	20 min.	1¼	
		Gauge Cocks	4x6=24	30x6x50%=90	114	50 min.	12	
		Gauge Cocks Overhauled	.....	30x6x50%=90	90	8 min.	1½	
		Air Pump Valves, 1" Angle	4x1= 4	30x50%=15	19	95 min.	3¾	
		Air Pump Valves Overhauled	.....	30x50%=15	15	25 min.	¾	
		Blower Valves, 1¼"	4x2= 8	30x2x50%=30	38	95 min.	7½	
		Blower Valves Overhauled	.....	30x2x50%=30	30	25 min.	1½	
		Injector Steam Valves, 2" Angle	4x2= 8	30x2x50%=30	38	2¼ hrs.	10¾	
		Injector Steam Valves Overhauled	.....	30x2x50%=30	30	30 min.	1⅞	
		Car Heater Valves	.....	30x25%=7	7	95 min.	1⅜	
		Car Heater Valves Overhauled	.....	30x25%=7	7	25 min.	⅜	
		Lubricator Valves, ¾" Angle	4x2= 8	30x2x50%=30	38	1½ hr.	7⅛	
		Lubricator Valves Overhauled	.....	30x2x50%=30	30	20 min.	1¼	
		Steam and Air Gauge Cocks	4x2= 8	30x4x50%=60	68	25 min.	3½	
		Steam and Air Gauge Cocks Overh'l'd	.....	30x4x50%=60	60	10 min.	1¼	
		Tallow Plugs	4x2= 8	30x2x50%=30	38	35 min.	2¾	
	1 Turret Lathe, 20"x6'	Tallow Plugs Overhauled	.....	30x2x50%=30	30	15 min.	1	149 days 5 mach.
	4 Turret Lathes, 18"x6'	Check Valves	4x2= 8	30x2x25%=15	23	2½ hrs.	7¼	
		Check Valves Overhauled	.....	30x25%=15	15	25 min.	¾	
		Air Cyl. Cocks	4x4=16	30x4x50%=60	76	2 hrs.	19	
		Air Cyl. Cocks Overhauled	.....	30x4x50%=60	60	8 min.	1	
		Pet Cocks, ⅜"	4x8=32	30x8x50%=120	152	30 min.	9½	
		Pet Cocks Overhauled	.....	30x8x50%=120	120	6 min.	1½	
		Blower Connection	4x2= 8	30x4x50%=60	68	18 min.	2½	
		Tallow Pipe Conn. and Nuts	4x2= 8	30x2x50%=30	38	17 min.	1⅓	
		Tank Cocks	4x1= 4	30x50%=15	19	70 min.	2¾	
		Tank Cocks Overhauled	.....	30x50%=15	15	20 min.	⅝	
		Whistle Elbow	4x1= 4	30x25%=8	12	18 min.	7/16	
		Cab Door Lock and Slides	4x4=16	30x4x25%=30	46	30 min.	3	
		Brazing Rings	.....	.....	500	.....	1	
		Ext., Gauge and Water Glass Cocks	4x8=32	30x8x25%=60	92	12 min.	¾	
		Pipe Sleeves and Nuts	.....	34x8x25%=68	68	17 min.	2½	
		Filling Plugs and Nuts, Lubricator	.....	.....	30	15 min.	1	
		Drain Plugs for Lubricators	.....	.....	30	.....	½	
		Sand Nozzles	.....	.....	50	.....	½	
		Safety Valve Extensions	4x2= 8	30x2x25%=15	23	20 min.	1	
		Nipples and Reducers	.....	.....	200	10 min.	4	
		Rocker Box Set Bolts	.....	30x8x25%=60	60	4 min.	½	
Air Brake Work		Air Pump Piston Rods	.....	30x50%=15	15	2½ hrs.	4⅔	
		Old Piston Rods Rep'd [6]	.....	30x50%=15	15	40 min.	1¼	15⅜ days 1 mach.
	1 Lathe, 16"x6'	Fulcrum Shaft	4x2= 8	30x2x25%=15	23	1½ hr.	4⅜	
		Refitting Brake Hanger Posts	4x6=24	30x6x75%=135	159	15 min.	5	
Rod Brasses	1 B. B. Ver. Milling Mach.	Shape or Mill	4x4=16	30x4=120	136	2 hrs.	34	1 mach.
	1 Ver. Rapid Prod. Lathe,	Bore and Face	4x4=16	30x4=120	136	40 min.	11⅓	25½ days
	37" Bullard, 4 Jaw Chuck	Bore Bushing and Turn	4x8=32	30x8=240	272	25 min.	14⅙	1 mach.
Miscellaneous Castings		Sand Boxes, Top and Base	4x1= 4	30x10%=3	7	3 hrs.	2⅝	
		Eng. Truck Tires	.....	30x3x10%=10	10	3 hrs.	3¾	26⅜ days
	1 Ver. Boring Mill, 51"	Dome Rings	4x1= 4	30x5%=2	6	2 hrs.	1½	1 mach.
		Crossheads, Face, Bore, Turn	4x2= 8	30x2x15%=9	17	8 hrs.	17	
		Crossheads, Rebore Old	.....	30x2x20%=12	12	1 hr.	1½	
		Sand Box Shaft	4x1= 4	30x10%=3	7	1 hr.	⅞	
		Bell Yoke	4x1= 4	30x25%=8	12	1½ hr.	2¼	
	1 Lathe, 24"x10'	Hand Holes and Covers	4x1= 4	30x50%=15	19	30 min.	1¼	19⅞ days
		Male Center Casting	4x1= 4	30x20%=6	10	2 hrs.	2½	1 mach.
		Mud Chambers	4x2= 8	30x2x50%=30	38	2 hrs.	9½	
		Tank Valve Racks	4x2= 8	30x2x50%=30	38	45 min.	3½	
		Expansion Braces	4x1= 4	30x10%=3	7	12 hrs.	10½	
		Guide Yokes	4x1= 4	30x15%=4	8	7 hrs.	7	
		Guide Yoke Brackets	4x2= 8	30x2x25%=15	23	3 hrs.	8⅝	
	1 Planer, 30"x8'	Guide Yoke Extensions	4x2= 8	30x2x10%=6	14	4 hrs.	7	
	1 Planer, 36"x10'	Castings [7]	4x4=16	30x4x10%=12	28	2½ hrs	9	
	1 Planer, 48"x12'	Filling Blocks	4x4=16	30x4x10%=12	28	2 hrs.	7	81¾ days
		Driver Brake Fulcrums	4x2= 8	30x2x10%=6	14	40 min.	1⅙	3 mach.
		Hopper Castings	4x1= 4	30x1x20%=6	10	40 min.	⅚	
		Drawhead Casting [8]	4x3=12	30x3x10%=9	21	6⅔ hrs.	17½	
		Chafing Blocks	4x1= 4	30x1x20%=6	10	1½ hrs.	1⅞	
		Crosstie Link Bracket, etc. [9]	4x1= 4	30x1x5%=2	6	15 hrs.	11¼	
	2 Radial Drills, 4' and 5'; 1 Ver. Drill, 32"	Drilling Miscellaneous Holes for New and Repair Work [10]	.....	.....	5500	.....	.....	3 mach.
Miscellaneous Forgings		Frame Braces	4x3=12	30x3x25%=23	35	3 hrs.	13⅛	
	1 Slotter, 12	Equalizer, Main	4x1= 4	30x10%=3	7	5 hrs.	4⅜	58¾ days
	1 Slotter, 18"	Pedestal Binders	.....	30x8x25%=60	60	1 hr.	7½	2 mach.
		Grate Bearing Bars	4x2= 8	30x2x25%=15	23	2 hrs.	5¾	
		Frame Rails	4x4=16	30x4x10%=12	28	8 hrs.	28	
		Pedestal Binders	4x8=32	30x8x10%=24	56	1⅓ hr.	9⅓	16⅓ days
	1 Planer, 42"x10'	Frame Braces	4x4=16	30x4x10%=12	28	2 hrs.	7	1 mach. [12]
	1 Radial Drill, 4'	Miscellaneous [11]	.....	.....	.....	.....	.....	.....
Staybolts	1 Lassiter 6-Spindle Mach.	Staybolts, Av. 7½" Long	4x1500=6000	30x1500x30%=13,500	19,500	1080 [1]	18	1 mach.
	1 4-Spindle Drill	Telltale Holes in Bolts	.....	.....	19,500	800 [1]	24⅜	1 mach.
Pin Work	1 Gisholt Lathe for 6" Stock	Crank Pins	4x6=24	30x6x50%=90	114	.....	.....	
	1 Gisholt Lathe for 4½"	Wrist Pins	4x2= 8	30x2=60	68	45 min.	6⅜	2 mach.
	Stock.	Knuckle Pins	4x4=16	30x4=120	136	20 min.	5⅔	

[1] Per day. [6] Old piston rods and heads filed and regrooved. [7] Center castings, female center, equalizer fulcrum, tender center castings. [8] Engine and tender, front and back. [9] Also lift shaft tie brace. [10] Drill center casting, engine and tender, fulcrum casting, expansion braces, filling blocks, driver brake fulcrum, hopper casting, drawhead castings, chaffing blocks, crosstie brace, mud chambers, tank valve racks, guide yokes, guide yoke brackets and extensions, sand boxes, dome rings, smoke box rings, fire door frames and doors, bell yokes and frames, hand hole plates and covers. [11] Drill frame braces, equalizers, binders, bearing bars and supports, crank pin collars, cab braces, foot board brackets, etc. Average 77 holes per day. [12] Available on miscellaneous castings.

Class of Work	Machine Tool	Operation	Number of Pieces per Month: New Engs.	Repairs	Total	Average Time per Piece	Total Days Work per Month	
Miscellaneous Pins, Studs, Etc.	1 Turret Lathe, 3"x36"	Studs, average length 4½"	4x600=2400	30x600x50%=9000	11,400	175[1]	65	123¼ days 5 mach.
	1 Turret Lathe, 2½"x24"	Pins, average length 7"	4x80=320	30x80=2400	2,720	60[1]	45	
	3 Turret Lathes, 2"x24"	Core Plugs, Piston Heads	4x8=32	30x8=240	272	125[1]	2¼	
		Wedge Adjusting Screws	4x8=32	30x8=240	272	40[1]	6¾	
		Driver Brake Adj. Screws	4x2= 8	30x2=60	68	16[1]	4½	
	1 Lassiter Bolt Turner, 4-Head	Bolts, Av. 7" Long	4x274=1896	30x474x50%=7110	9006	300[1]	30	1 mach.
	1 Centering Machine, 2"							1 mach.
	2 Lathes, 14"x5'	For Fitting Bolts						2 mach.
	3 Lathes, Portable[12]	For Fitting Bolts						3 mach.
	1 Bolt Pointer, 2"							1 mach.
	1 Threading Machine, D.H.							1 mach.
	1 Nut Tapper							1 mach.
	1 Nut Facing Machine							1 mach.
	1 Mach. for Pipe Nipples							1 mach.
	1 Pipe Cutting Mach., 6"							1 mach.
	2 Friction Drills, 13"							2 mach.

[1] Per day. [12] For erecting shop (14"x5').

The fact that the ability of roads generally in realizing the full advantage to be obtained from the use of cast steel frames, is dependent upon the facilities for machining and finishing them, leads to the selection of some tools not generally found outside of builders shops, and as such tools might be considered as of more or less intermittent character, special consideration has been made in their selection with a view of adapting them for general work, when not fully occupied on new work, in order to keep the surcharge down to the lowest possible point.

The forging department has received careful consideration and the general plan, and the selection and arrangement of tools, together with the further fact that water gas is to be used in the heating furnaces warrants the assumption that this department will bear its full share in preserving the integrity of the output.

The study has been based upon eight working hours per day. In some instances it will be noted that only one machine tool is provided where it is apparent that more work will be required of it than can be performed during the regular working hours. In such cases it has been deemed advisable to have the machine work over-

TOOL ROOM MACHINES.

1 Universal Miller.
2 Plain Millers, one 14" x 6' table, and one 39" x 10'.
4 Lathes: one 14" x 6'; one 16" x 8'; one 16" x 8'; one 12" x 6'.
2 Drill Presses: one 13" and one 25".
1 Shaper, 14".
1 Crank Planer, 20 x 20 x 24½ in. stroke.
1 2 x 24 in. Turret Lathe.
1 Gisholt Tool Grinder.
1 Sellers Tool Grinder.
1 Reamer Grinder.
1 Cutter Grinder.
1 Die Grinder.
2 Twist Drill Grinders.

(Continuation of Table on Opposite Page.)

Class of Work	Machine Tool	Operation	Number of Pieces per Month: New Engs.	Repairs	Total	Average Time per Piece	Total Days Work per Month	
Roll	1 Bending Roll, 15'	Crown Sheet of Firebox	4x1= 4	30x1x25%=7	11	1 hr.	1¾	2 mach.
	1 Bending Roll, 8'	Side Sheets, Firebox	4x2= 8	30x2x27%=16	24	1½ hr.	3	
		Crown Sheets, Boiler	4x1= 4	30x1x4%=1	5	1 hr.	⅝	
		Side Sheets, Boiler	4x2= 8	30x2x4%=2	10	1 hr.	1¼	
		Cyl. Courses, Boiler[6]	4x1= 4	30x1x4%=1	5	4½ hrs.	2¾	
		Smoke Arches	4x1= 4	30x1x25%=7	11	1½ hrs.	2	
		Domes	4x1= 4	30x1x4%=1	5	45 min.	3¾	
		Smoke Arch Rings	4x1= 4	30x1x25%=7	11	1 hr.	1⅜	
		Smoke Arch Liners	4x1= 4	30x1x25%=7	11	30 min.	11/16	
		Cistern Sheets	4x1= 4	30x1x10%=3	7	4 hrs.	3½	
		Hopper Chutes	4x1= 4	30x1x10%=3	7	30 min.	7/16	
		Draft Pipes	4x1= 4	30x1x10%=3	7	30 min.	7/16	
		Engineer's Cab Roofs	4x1= 4	30x1x4%=1	5	30 min.	5/16	
		Tank Cabs	4x1= 4	30x1x10%=3	7	30 min.	7/16	
		Fireman's Cabs	4x1= 4	30x1x10%=3	7	30 min.	7/16	
		Manholes for Cistern	4x1= 4	30x1x20%=6	10	20 min.	⅝	
Plane	1 Plate Planer, 30'	Crown Sheets, Firebox	4x1= 4	30x1x25%=7	11	1½ hr.	2	16 days 1 mach.[12]
		Side Sheets, Firebox	4x2= 8	30x2x27%=16	24	1½ hrs.	4½	
		Crown Sheets, Boiler	4x1= 4	30x1x4%=1	5	1½ hrs.	1	
		Side Sheets, Boiler	4x2= 8	30x2x4%=2	10	1½ hrs.	2	
		Cyl. Courses for Shell[7]	4x1= 4	30x1x4%=1	5	6 hrs.	3¾	
		Smoke Arches	4x1= 4	30x1x25%=7	11	1½ hr.	2	
		Running Boards	4x4=16	30x4x10%=12	28	10 min.	⅝	
Hyd. Riveting	Hyd. Gap Riveter, 17' Throat, 54" Gap	Riveting Boiler	4x1= 4	30x1x4%=1	5	2 days	10	1 mach.
Drilling	1 Radial Drill, 6'	Plate Frames	4x1= 4	30x1x75%=22	26	3 hrs.	9¾	89¾ days 3 mach.
	1 Horizontal Drill	Bearing Bar Support Brackets	4x4=16	30x4x10%=12	28	10 min.	⅝	
	1 4 Spindle Drill	Shaker Rods and Brackets	4x1= 4	30x1x25%=7	11	3½ hrs.	4¾	
		Tender Frames	4x1= 4	30x1x10%=3	7	3 days	21	
		Plug Holes in Back Head	4x5=20	30x5x4%=5	25	8 min.	⅜	
		Flue Holes	4x2x350=2800	30x2x350x20%=4200	7000		24	
		Smoke Arch Front Ring	4x1= 4	30x1x25%=7	11	6 hrs.	8¼	
		Bead Iron for Cistern	4x1= 4	30x1x10%=3	7	2 hrs.	1¾	
		Dome Saddle	4x1= 4	30x1x4%=1	5	6 hrs.	3¾	
		Dry Pipe Hole in Flue Sheet	4x1= 4	30x1x20%=6	19	1 hr.	1½	
		Reinforcing Ring	4x1= 4	30x1x20%=6	10	1 hr.	1¼	
		Bearing Bar Supports	4x2= 8	30x2x25%=15	23	15 min.	¾	
		Mud Ring	4x1= 4	30x1x10%=3	7	14 hrs.	12¼	
Flue Work	Flue Rattler	Clean Flues		30x350=10,500	10,500			1 mach.
	1 Cutting-off Mach.	Making Safe Ends		30x350=10,500	10,500		22	3 mach.
	2 Cutting-off Mach.	Measure and Cut to Length	4x350=1400	30x350=10,500	11,900		56	
		Cutting Off Rough Ends		30x350=10,500	10,500		16¼	
	2 D. H. Welding Machines	Flues Scarfed		30x350=10,500	10,500		16¼	2 mach.
		Flues Welded and Swaged		30x350=10,500	10,500		24	

[6] Three courses included. [7] Three courses included. [12] Available for planing throat sheets, flue sheets and door sheets on flange.

A STUDY OF THE MACHINE TOOL OPERATIONS REQUIRED IN A RAILROAD LOCOMOTIVE BOILER SHOP, FOR MAKING REPAIRS TO AND BUILDING THE FOLLOWING NUMBER OF CONSOLIDATION LOCOMOTIVES PER MONTH, THE SHOP OPERATING EIGHT HOURS PER DAY: 30 GENERAL REPAIRS, 8 LIGHT REPAIRS AND FOUR NEW LOCOMOTIVES.

Class of Work	Machine Tool	Operation	Number of Pieces per Month: New Engs.	Number of Pieces per Month: Repairs	Number of Pieces per Month: Total	Average Time per Piece	Total Days Work per Month	
Shearing and Punching	1 Throat Shear, 60"; 1 Throat Shear, 36"	Flue Sheet, P. and S.	4x2= 8	30x2x20%=12	20	1 hr.	2½	63 11/16 days 2 mach.
		Door Sheet, Firebox, P. and S.	4x1= 4	30x1x25%=7	11	3 hrs.	4⅛	
		Door Sheet, Back Head, P. and S.	4x1= 4	30x1x10%=3	7	3½ hrs.	3	
		Throat Sheet, Firebox, P. and S.	4x1= 4	30x1x25%=7	11	3½ hrs.	4¾	
		Throat Sheet, Boiler, P. and S.	4x1= 4	30x1x4%=1	5	4 hrs.	2½	
		Crown Sheet, Boiler, Shear	4x1= 4	30x1x4%=1	5	45 min.	3¾	
		Crown Sheet, Firebox, Shear	4x1= 4	30x1x25%=7	11	45 min.	1	
		Side Sheets, Firebox, Shear	4x2= 8	30x2x27%=16	24	1 hr.	3	
		Side Sheets, Boiler, Shear	4x2= 8	30x2x4%=2	10	1 hr.	1¼	
		Cyl. Courses, Shear [a]	4x1= 4	30x1x4%=1	5	3 hrs.	1⅞	
		Smoke Arch, Shear	4x1= 4	30x1x25%=7	11	2½ hrs.	3⅜	
		Smoke Arch Liner, Shear	4x1= 4	30x1x25%=7	11	30 min.	11/16	
		Expansion Sheets, Shear	4x1= 4	30x1x10%=3	7	20 min.	¼	
		Brace Sheets, Shear	4x2= 8	30x2x10%=6	14	1 hr.	1¾	
		Cistern Sheets, Shear	4x1= 4	30x1x10%=3	7	4 hrs.	3½	
		Ash Pan Hopper and Wheel Covers	4x1= 4	30x1x30%=9	13	4 hrs.	6½	
		Grease Box Cases	4x10=40	30x10x25%=75	115	10 min.	2⅜	
		Grease Box Plates	4x10=40	30x10x25%=75	115	5 min.	1¼	
		Fireman's Cab	4x1= 4	30x1x15%=4.5	8.5	4 hrs.	4¼	
		Engineer's Cab	4x1= 4	30x1x10%=3	7	6 hrs.	5¼	
		Foot Boards	4x4=16	30x4x5%=6	22	20 min.	1	
		Tank Cabs	4x1= 4	30x1x15%=4.5	8.5	1 hr.	1	
		Deck Plates	4x4=16	30x4x10%=12	28	10 min.	⅝	
		Diaphragm Plates	4x1= 4	30x1x10%=3	7	15 min.	¼	
		Draft Pipe and Netting	4x1= 4	30x1x10%=3	7	20 min.	¼	
		Hopper Chutes	4x1= 4	30x1x10%=3	7	20 min.	¼	
		Coal Box for Tenders	4x1= 4	30x1x10%=3	7	20 min.	¼	
		Shoe and Wedge Liners	....	30x32x75%=720	720	....	⅜	
		Coal Aprons	4x1= 4	30x1x10%=3	7	30 min.	7/16	
		Pilot Steps	4x2= 8	30x2x50%=30	38	5 min.	⅜	
		Wedge Sheets	4x1= 4	30x1x10%=3	7	20 min.	¼	
		Wind Shields in Cab	4x2= 8	30x2x10%=6	14	15 min.	7/16	
		Cylinder Plates	4x2= 8	30x2x10%=6	14	10 min.	¼	
		Bumper Beam Sheets	4x1= 4	30x1x10%=3	7	20 min.	¼	
		Cab Sheets	4x2= 8	30x2x10%=6	14	10 min.	¼	
		Tool Boxes	4x1= 6	30x1x10%=3	7	20 min.	¼	
		Flag Boxes	4x1= 4	30x1x10%=3	7	10 min.	⅛	
		Cab Ventilators	4x1= 4	30x1x10%=3	7	10 min.	⅛	
Punching	1 Throat Punch, 60"; 1 Throat Punch, 36"; 1 Throat Punch, 16"	Flue Sheets, Front and Back	4x2= 8	30x2x20%=12	20	1¾ hr.	4⅜	67½ days 3 mach.
		Door Sheet, Fire Box	4x1= 4	30x1x25%=7	11	1¼ hr.	1¾	
		Door Sheet, Back Head	4x1= 4	30x1x10%=3	7	1⅔ hr.	1½	
		Throat Sheet, Fire Box	4x1= 4	30x1x25%=7	11	45 min.	1	
		Throat Sheet, Boiler	4x1= 4	30x1x4%=1	5	40 min.	½	
		Crown Sheet, Boiler	4x1= 4	30x1x4%=1	5	3¾ hrs.	2⅓	
		Crown Sheet, Fire Box	4x1= 4	30x1x25%=7	11	3¾ hrs.	5⅛	
		Side Sheets, Boiler	4x2= 8	30x2x4%=2	10	2¾ hrs.	3 7/16	
		Side Sheets, Fire Box	4x2= 8	30x2x27%=16	24	3 3/10 hrs.	10	
		Cyl. Courses of Boiler	4x1= 4	30x1x4%=1	5	8⅓ hrs.	5⅛	
		Smoke Arches	4x1= 4	30x1x25%=7	11	1⅜ hr.	1⅞	
		Smoke Arch Liners	4x1= 4	30x1x25%=7	11	1 hr.	1⅜	
		Expansion Sheets	4x1= 4	30x1x10%=3	7	15 min.	¼	
		Brace Sheets	4x2= 8	30x2x10%=6	14	45 min.	1 5/16	
		Ash Pan Hoppers and Wheel Covers	4x1= 4	30x1x30%=9	13	5 hrs.	8⅛	
		Grease Box Cases	4x10=40	30x10x25%=75	115	1½ min.	⅜	
		Fireman's Cabs	4x1= 4	30x1x15%=4.5	8.5	4 hrs.	4¼	
		Engineer's Cabs	4x1= 4	30x1x10%=3	7	7 hrs.	6⅛	
		Running Boards	4x4=16	30x4x5%=6	22	20 min.	⅞	
		Tank Cabs	4x1= 4	30x1x15%=4.5	8.5	2 hrs.	2⅛	
		Deck Plates	4x4=16	30x4x10%=12	28	6 min.	⅜	
		Diaphragm Plates	4x1= 4	30x1x10%=3	7	8 min.	⅛	
		Draft Pipes	4x1= 4	30x1x10%=3	7	15 min.	¼	
		Hopper Chutes	4x1= 4	30x1x10%=3	7	8 min,	⅛	
		Coal Box for Tender	4x1= 4	30x1x10%=3	7	15 min.	¼	
		Coal Aprons	4x1= 4	30x1x10%=3	7	10 min.	⅛	
		Pilot Steps	4x2= 8	30x2x50%=30	38	10 min.	¾	
		Wind Shields, Fireman's Cab	4x1= 4	30x1x10%=3	7	20 min.	¼	
		Wind Shields, Engr's Cab	4x2= 8	30x2x10%=6	14	6 min.	3/16	
		Cab Sheets	4x2= 8	30x2x10%=6	14	3 min.	1/16	
		Wind Shields in Cab	4x2= 8	30x2x10%=6	14	15 min.	7/16	
		Cylinder Plates	4x2= 8	30x2x10%=6	14	5 min.	⅛	
		Bumper Beam Plate	4x1= 4	30x1x10%=3	7	10 min.	⅛	
		Tool Box	4x1= 4	30x1x10%=3	7	30 min.	7/16	
		Flag Box	4x1= 4	30x1x10%=3	7	10 min.	⅛	
		Cab Ventilator	4x1= 4	30x1x10%=3	7	5 min.	1/16	
		Tender Frames	4x1= 4	30x1x4%=1	5	3⅓ hrs.	2	
	1 Punch and Shear and 25' Spacing Table; 1 Flange Punch	Cistern Sheets	4x1= 4	30x1x10%=3	7	2¾ days	19¼	2 mach.
		Flue Sheets, Front and Back	4x2= 8	30x2x20%=12	20	25 min.	1	
		Throat Sheets, Fire Box	4x1= 4	30x1x25%=7	11	45 min.	1	
		Throat Sheets, Boiler	4x1= 4	30x1x4%=1	5	95 min.	1	
		Door Sheets, Back Head	4x1= 4	30x1x4%=1	5	45 min.	½	
		Door Sheets, Fire Box	4x1= 4	30x1x25%=7	11	35 min.	13/16	
Flanging	1 Hydraulic Flange Press	Back Flue Sheets	4x1= 4	30x1x20%=6	10	45 min.	15/16	15⅓ days 1⅓ mach.
		Front Flue Sheets	4x1= 4	30x1x20%=6	10	45 min.	15/16	
		Throat Sheet, Firebox	4x1= 4	30x1x20%=6	10	3 hrs.	3¾	
		Throat Sheet, Boiler	4x1= 4	30x1x4%=1	5	4 hrs.	2½	
		Dome Saddles	4x1= 4	30x1x4%=1	5	1 hr.	⅝	
		Door Sheet, Firebox	4x1= 4	30x1x25%=7	11	1 hr.	1⅜	
		Door Sheet, Boiler Back Head	4x1= 4	30x1x4%=1	5	2½ hrs.	1½	
		Door Holes	4x2= 8	30x2x20%=12	20	30 min.	1¼	
		Steam Chest Casing	4x2= 8	30x2x10%=6	14	12 min.	⅓	
		Cyl. Head Casings	4x4=16	30x4x10%=12	28	10 min.	⅝	
		Sand Box Casings	4x1= 4	30x1x10%=3	7	45 min.	⅔	
		Dome Casings	4x2= 8	30x2x10%=6	14	45 min.	1⅓	

[a] Three courses included. Note.—Where not definitely specified, items under "Shearing and Punching" are sheared only.

(The Continuation of this Table will be Found at the Bottom of page 126.)

time, which may, of course, readily be done where the tools are driven by individual motors.

All of the new locomotives are to be equipped with Walschaert valve gear; the study is based upon the supposition that 80 per cent. of the engines in service have Stephenson gear, the remaining ones being equipped with the Walschaert gear.

On roads where each individual operation has been carefully studied, as, for instance, where piecework methods are used or schedules tabulated by time studies or other shop efficiency methods, there is no reason why a complete analysis of this kind could not be made for a new shop which is to turn out a similar class of work. The output is affected by so many conditions, such as the design and the type of the locomotives, the organization of the shop and its method of operation, the class of tools and the way in which they are driven, and the tool steel which is used, that it is, of course, necessary to make an individual study for each shop.

The writer was enabled to make these studies through the courtesy of T. S. Lloyd, superintendent of motive power and machinery of the Delaware, Lackawanna & Western Railroad and with the assistance of Thomas Jeffrey, general piecework inspector of that road.

SETTING VALVES ON LOCOMOTIVES WITH WALSCHAERT GEAR.*

OSCAR ANTZ.†

When the Walschaert valve gear was first introduced in this country, the impression was common that it was designed entirely on the drawing board and that no variations from the figures thus obtained must be allowed; later on it became evident that these exact dimensions cannot always be maintained, but outside of the locomotive works it does not, even now, seem to be generally known what is the best way of setting the valves and determining what to change to obtain certain results. The Stephenson link motion is usually set entirely by the lead, and as the Walschaert gear is designed to have constant lead at all points, it is believed by many that this is the first and only object to be obtained in setting the valves, the other events being correct as a natural consequence. While this is approximately so, it is not an easy matter and requires some calculations to determine just what is necessary to change, and how much to change it, to obtain this constant lead when more than one part is incorrect. What is therefore recommended as the best and at the same time the simplest method is to practically lay out the gear on each individual locomotive. This is not, by far, as complicated as it sounds, and may not be new to some, but as it is not generally known, it will be treated at some length.

It is assumed that the gear has been correctly designed and that the proportions of the combination lever are such that the travel of the valve in midgear is exactly twice the sum of the lead and lap. Such being the case, it is not necessary to measure the lead until the valves are practically set and ready to run over. It is further assumed that the parts have all been made to the drawings and have been checked as correct; that the valves and seats are of the correct dimensions to give the desired lap and exhaust clearance, and that the locomotive is on its wheels and ready to have the valves set. Then proceed as follows for each side of the locomotive.

First:—Put the main wheels on rollers and have the main rod in place connected to the crosshead; have the valve in place and connected; have all parts of the valve gear in place and connected, except the union link and eccentric rod.

Find the exact front and back dead centers of the crank pin in the usual way and mark them on the wheel with a tram from the frames. Put marks on the guides and crosshead indicating the extreme front and back ends of the travel of the crosshead, also mark the point midway between these. Get "port marks" on the valve stem or other convenient part in the usual manner showing points of opening and closing of steam and exhaust sides of the valve.

Second:—Put the link block in the exact center of the link. This can be ascertained by raising and lowering the block by means of the reverse lever and oscillating the link (see Fig. 1) by taking hold of the lower (now loose) end until there is no motion to the valve and combination lever. Should it not be possible to get both sides to remain stationary with one position of the reverse lever, adjustment must be made on either side in the lifting device until they do so.

Put the crosshead in the middle of its travel, and with straight edges on the lower guides and a tri-square (A, Fig. 1) move the combination lever, loose at the lower end, until a line through the centers of the upper two holes is square with the guides. Usually the three holes in this lever are in the same straight line, but in case they are not, the line through the upper two should be taken.

Tram the location of the valve and if it is not in central posi-

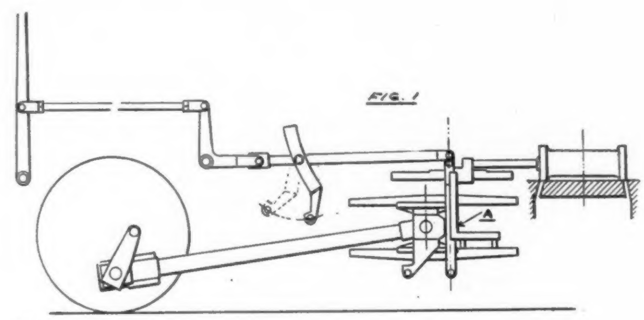


FIG. 1

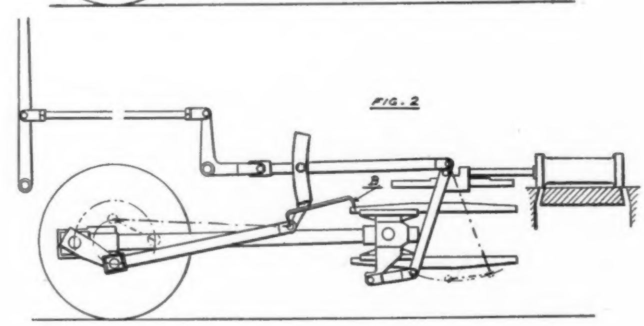


FIG. 2

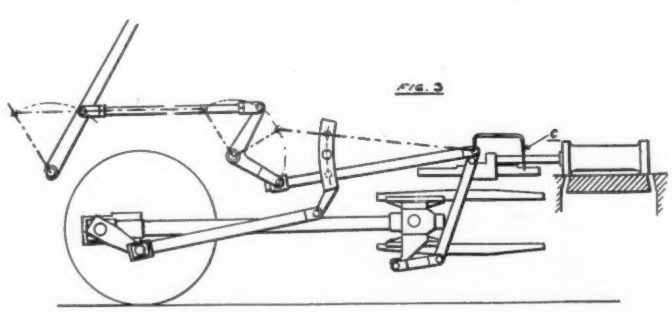


FIG. 3

tion with the valve seat, adjust the valve stem so that the valve is central and change the port marks to suit.

Connect the union link: it should not move the combination lever out of its vertical position; if it does so, adjust the length of the union link.

Third:—Connect the eccentric rod and put the engine on one center; with a convenient tram put a mark on the frame or an attached part, such as the guides, from the center of the front pin of the eccentric rod (B, Fig. 2). Move the engine to the other center and make a similar mark. These marks should coincide; if they do not, move the eccentric crank on the main pin

* See also AMERICAN ENGINEER, November, 1908, p. 434.
† Supervisor of Valve Motion, L. S. & M. S. Ry.

until they do. The amount of the necessary change is one-half of the horizontal distance between the two marks made with the tram, measured on a horizontal line through the eccentric crank pin.

Fourth:—Put the engine on either center and move the reverse lever from extreme forward to extreme backward position; the combination lever and valve should not move. If they do, the length of the eccentric rod must be adjusted so that there will be no motion; the amount of the necessary change being one-half of the motion of the forward end of the radius arm, conveniently measured with a tram (C, Fig. 3), multiplied by the ratio of the link arm radius to that of the link block, that is, the distance of the center of this block in extreme upper or lower position from the center of the link.

The valves are now approximately set as close as it is possible on this particular locomotive and are ready to be run over to get the different valve events.

On account of the errors introduced when changing rectilinear to circular motion and vice versa, which occurs three times in this valve gear, there are always certain irregularities to be found in the valve events which can be minimized but never entirely overcome; two of these are important enough to be considered. It is assumed that the work of adjusting the parts was carefully done and that they are correct.

The lead may be found to be more at one end than at the other, which will probably be due to the fact that the union link swings more to one side of a horizontal line than to the other; this can be corrected to a slight degree by adjusting the length of the union link.

The valve travel may be found to be more at one end than at the other; this can be corrected by slightly adjusting the length of the front end of the radius arm to make the travel nearer equal, and adjusting the length of the union link to keep the lead equal. This will throw the combination lever out of square with the guides in mid position and will also affect some of the other valve events.

None of these changes if considerable is advised until the motion is laid out on the drawing board and its effect ascertained and the best amount of the change determined. If after this, a still closer adjustment is desired, the entire gear must be redesigned.

HOW ONE OF THE RAILROADS SELECTS ITS NEW MACHINE TOOLS.

It may be of interest to many of our readers to know just how a large railroad, such as the Pennsylvania, selects its new machine tools. In the fall of each year each grand division submits to the general superintendent of motive power its estimated requirements for new tools for the coming year, covering replacements and additional equipment, to meet the conditions which it is estimated will obtain at the several shops of the respective divisions. These requirements are studied in the office of the general superintendent of motive power and eliminations and additions made as deemed advisable, after which a tool program is prepared therefrom, with the estimated costs, and is submitted to the executive officers for approval.

C. I.

THE PENNSYLVANIA RAILROAD COMPANY.

PHILADELPHIA, BALTIMORE & WASHINGTON RAILROAD COMPANY.
NORTHERN CENTRAL RAILWAY COMPANY
WEST JERSEY & SEASHORE RAILROAD COMPANY.

SHAPER. TRANSACTION No. ....

Number required, ... which should conform to the following requirements:

Type, ...

Stroke of tool, ...

Max. distance between tools, (double head) ....

Drive, Belt, ...
Motor, voltage, ... D. C., ...
Motor, voltage, ... A. C. phase, ... Cycles, ...

Attachments, ...

The following information should be furnished by the manufacturer:

Maximum stroke, ... Length of bed, ...

Max. longitudinal travel of head, ...

Max. and min. distance from table to underside of head, ...

Speed of cutting stroke, ... Ratio cut to return, ...

Range of speeds, ... Range of feeds, ...

Horse power of motor, ...

Weight, (without motor) ....

F. O. B. at ....

Earliest delivery, ...

Price, ...

Name of manufacturer, ...

Date, ... Agent, ...

NOTE: Any variation from the above requirements must be fully stated, and any alternate proposition must be made on a separate blank.

FORM TO BE FILLED IN BY THE MACHINE TOOL BUILDER.

After the program has been approved, each division is informed as to the amount appropriated, and the superintendents of motive power request the purchasing agent to obtain bids from the various manufacturers for the kind and style of tools they desire. In requesting these bids the purchasing agent forwards to the machine tool builders a form covering the particular tool required. One of these forms, for a shaper, is shown in the illustration. In returning these blanks, filled in, to the purchasing agent, the bidders usually write to him, calling attention to any new attachments which may be on the machines, etc.

These letters are forwarded to the superintendent of motive power who requested the bids, and the information is transferred to a sheet, which condenses the information from all the bidders. After further investigation of the relative merits and adaptability of the tools the requisitions are made out by the superintendent of motive power and sent to the office of the general superintendent of motive power for approval, together with the individual bids and the condensed sheet before mentioned, as well as a letter explaining their preference for the machines specified on the requisitions. When the requisitions and bids are received in the office of the general superintendent of motive power they are carefully gone over. If the general superintendent of motive power can advise that there is some other machine in the market with features that make it more adaptable for the service than the one specified, or when it is known that the machine specified has not been a success at some other point, the requisition is changed accordingly. When approved by the general superintendent of motive power the requisition is returned to the superintendent of motive power, who forwards it through the regular channel to the purchasing agent.

It is understood that the various divisions, as well as the office of the general superintendent of motive power, shall keep in touch with the improvements that are made in machine tools from time to time, by carefully noting the catalogs and descriptive matter received from the machine tool builders, and by personal visits to other shops and manufacturing plants, making notes of machines for special work, and new attachments on machines with which the motive power department is familiar, for future reference.

THE MINERAL PRODUCTION IN THE UNITED STATES now exceeds two billion dollars per annum, and it contributes more than 65 per cent. to the total freight traffic of the country. We now produce nearly 500,000,000 tons of coal per annum, or 40 per cent. of the world's product. We also produce 58 per cent. of the world's iron; 22 per cent. of the world's gold; 60 per cent. of the world's copper.

TO FIND THE WEIGHT OF CASTINGS multiply the cubic inches by 0.27 for iron, 0.29 for steel and 0.30 for brass.

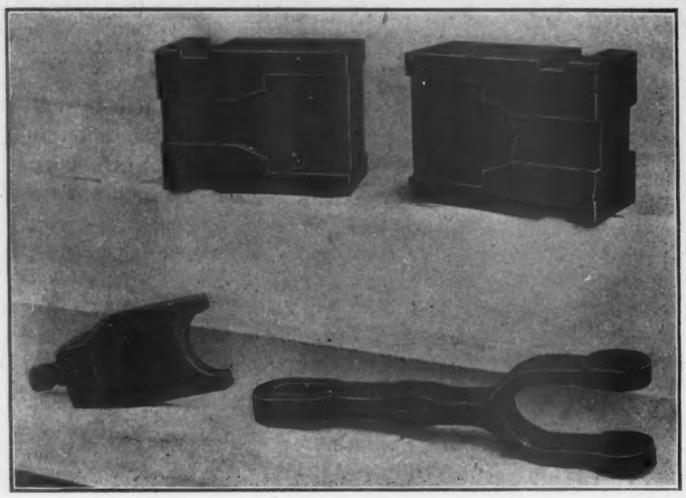


FIG. 1.—FIRST OPERATION, TRUCK HANGER.

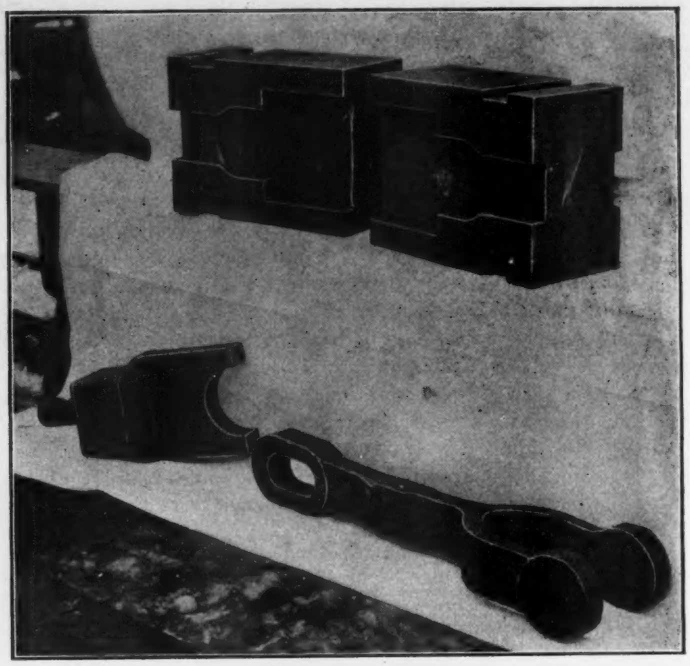


FIG. 2.—SECOND OPERATION, TRUCK HANGER.

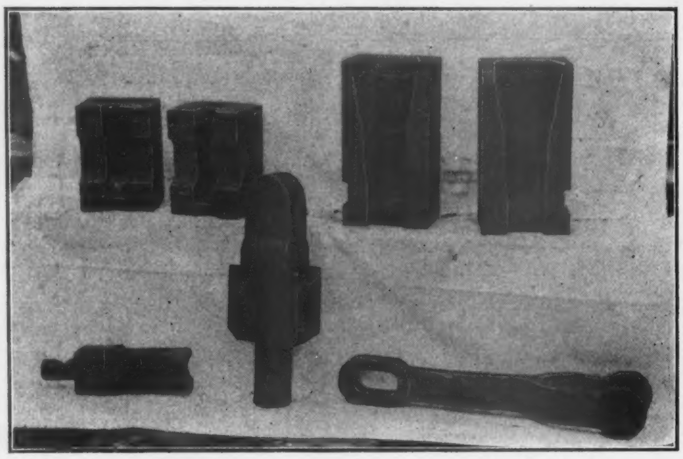


FIG. 3.—FINAL OPERATION, TRUCK HANGER.

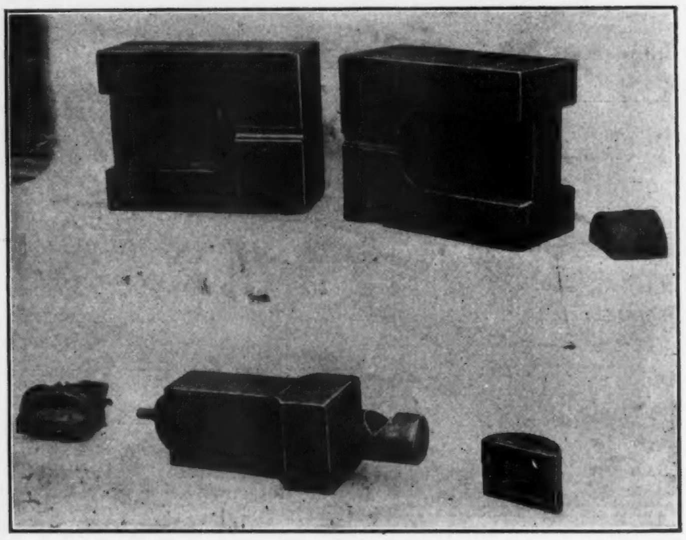


FIG. 5.—DIES AND FORMER FOR DRAWBAR YOKE FILLER.

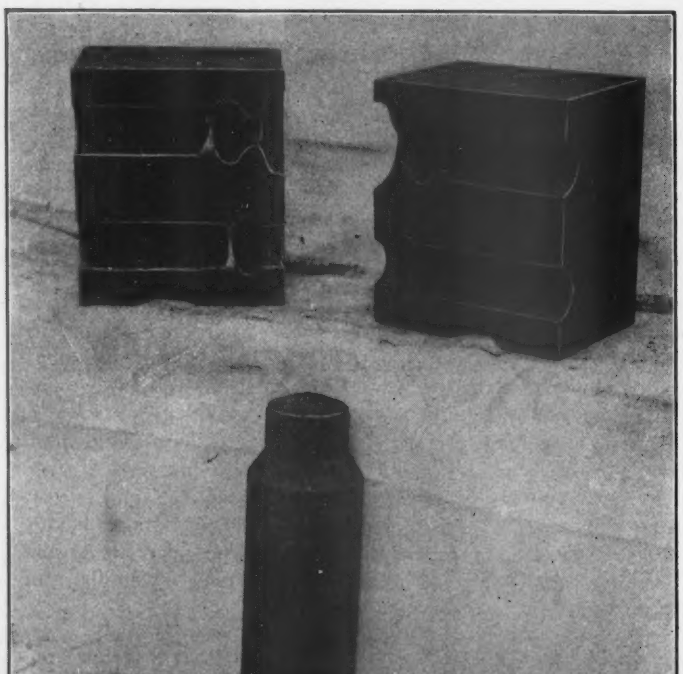


FIG. 7.—DIES AND FORMER FOR BAGGAGE CAR DOOR KNOB.

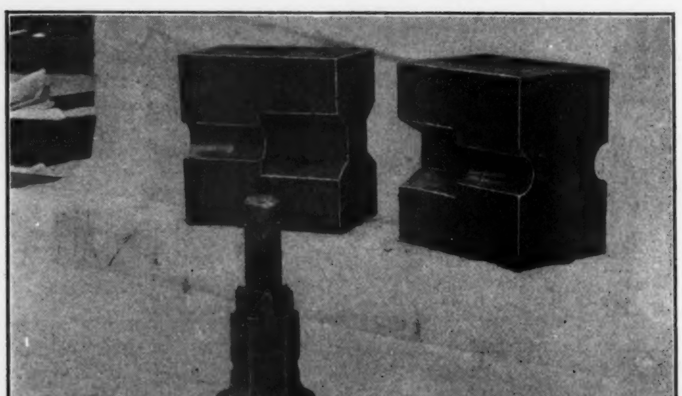


FIG. 6.—DIES AND FORMER FOR CASTLE NUT.

FORGING AT THE COLLINWOOD SHOPS.*

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

Truck Hanger.—The dies and formers for forging a truck hanger for the standard Lake Shore & Michigan Southern Railway four-wheel passenger truck are shown in Figs. 1, 2 and 3. The hanger is made of two pieces of wrought iron 1⅛ by 3 in. in size. These pieces are heated and bosses are forged on the ends which form the fork, while they are separate, by the dies shown in Fig. 1. The two pieces are then clamped together, heated to a welding heat and the slotted end is formed by using the dies shown in Fig. 2; the two pieces are welded together at this end at the same time by squeezing them tight between the jaws with the side motion of the machine. The jaw, or forked end, is opened with a common wedge in a bulldozer.

The forked end of the hanger is then reheated and brought to a welding heat. It is placed in the forging machine and the jaw is finished and that end of the body of the hanger is completely welded together by the dies and former shown at the right in Fig. 3. The slotted end of the hanger is then heated and the slot is punched with the dies and punch shown at the left in the same photograph. The center of the hanger is drawn to

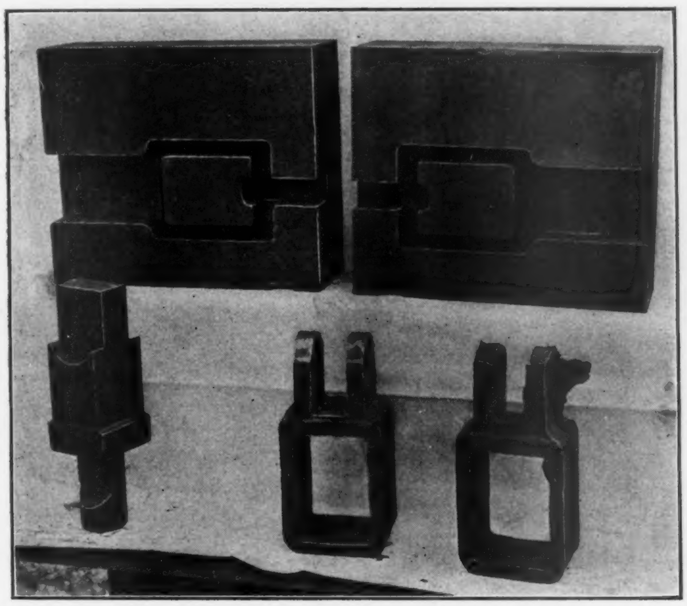


FIG. 4.—DIES AND FORMER FOR SPRING HANGER.

length and finished under a steam hammer. This makes a very satisfactory hanger and costs less than a steel casting.

Spring Band.—A spring band for an under-hung type of spring and the dies and former for forging it are shown in Fig. 4. The band is formed from a 1 by 5 in. bar of commercial iron. The bar is bent to suitable shape to go into the die; a filler is placed between the two pieces and it is completed in one stroke of the machine. This makes a strong spring band at a very low cost.

Drawbar Yoke Filler.—The filling block for the back end of a curved drawbar yoke, and the dies and former for making it, are shown in Fig. 5. These blocks are usually made of malleable iron, but it has been found that they may be made more cheaply by forging them. The forged block is made from pieces of different size arch bars, varying from 1 by 3 in. to 1¼ by 4 in. The pieces are cut to the proper length to insure the same cubical contents; a hole is punched in the center and the piece is bent into a "U" shape, heated to a welding heat, placed between the dies of the forging machine, one blow of which causes the metal to flow to the shape shown in the photograph, welding it along the center line and maintaining the hole and completing the block.

It is important that these pieces be placed in the machine by inserting a bar in the hole, which is punched in the blank, thus insuring the blank fitting in a central position in the die. It sometimes happens that there is not sufficient metal to complete the block. In such cases a second heat is taken and pieces of iron, the required size to fill up, are placed in the recess of the block and both pieces are heated to a welding heat. Another operation of the machine will then turn out a complete block. The recesses are made in the side to bring the wrought iron block to the same weight as that of malleable iron.

Castle Nut.—A 2½ in. castle nut † and the dies, former and blank for making it are illustrated in Fig. 6. The guide pin or mandrel and punch for piercing the blank to form the castellations, are made in one piece with a threaded projection on the opposite end. This is screwed into the hexagon of the head, making a very simple form of header. The blank is made from a piece of commercial iron about ⅝ by 5 in. and is bent cold in the bulldozer to the shape shown in the photograph. It is then heated to a welding heat and placed between the dies; one blow of the machine welds it solid, forms the hexagon, pierces the castellations and finishes the nut complete, as shown.

Door Knobs.—Considerable trouble is found in getting a satisfactory porcelain door knob for baggage cars. Brass door knobs are stolen. The problem has been solved on the Lake Shore by using iron forgings, the dies and former for making them being shown in Fig. 7. The knob is formed with one blow of the machine from a round bar of iron in the lower part of the dies. It is then placed in the upper part of the dies where it is completed.

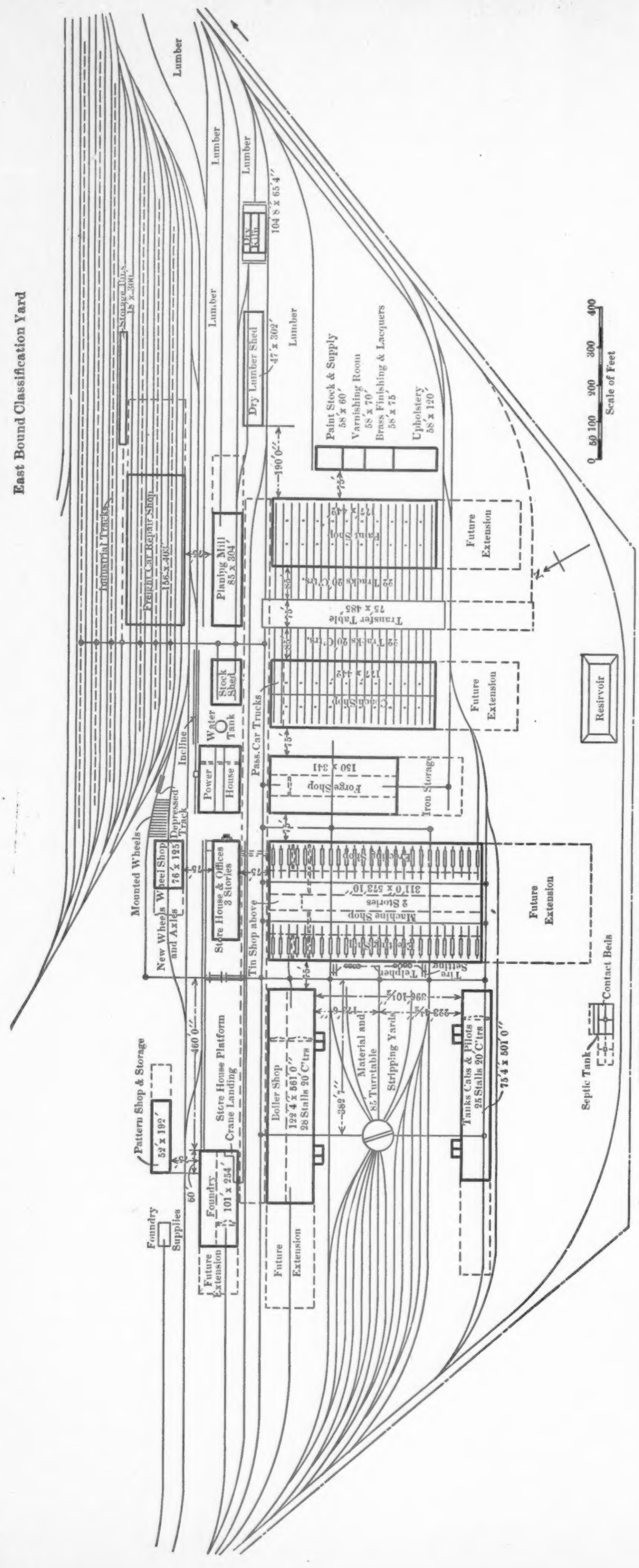
These forgings were all made on 3½ and 5 inch Ajax forging machines. For the past three or four years the Collinwood smith shop has been very successful in using compressed air for making difficult welds in these machines. An air pipe is connected to the forging machine dies and is so arranged that it may be directed on the parts to be welded. The high pressure air coming in contact with the heated parts, blows off the scale and dirt and raises the temperature of the heated iron to the point of fusion. With this method a poor weld is very rare.

† The method of forging castle nuts from ¾ to 1¾ in. in size on the C. M. & St. P. Ry. is described in the November, 1908, issue, page 427. The dies and former for making the smaller size nuts at Collinwood were illustrated in the May, 1907, issue, page 192.

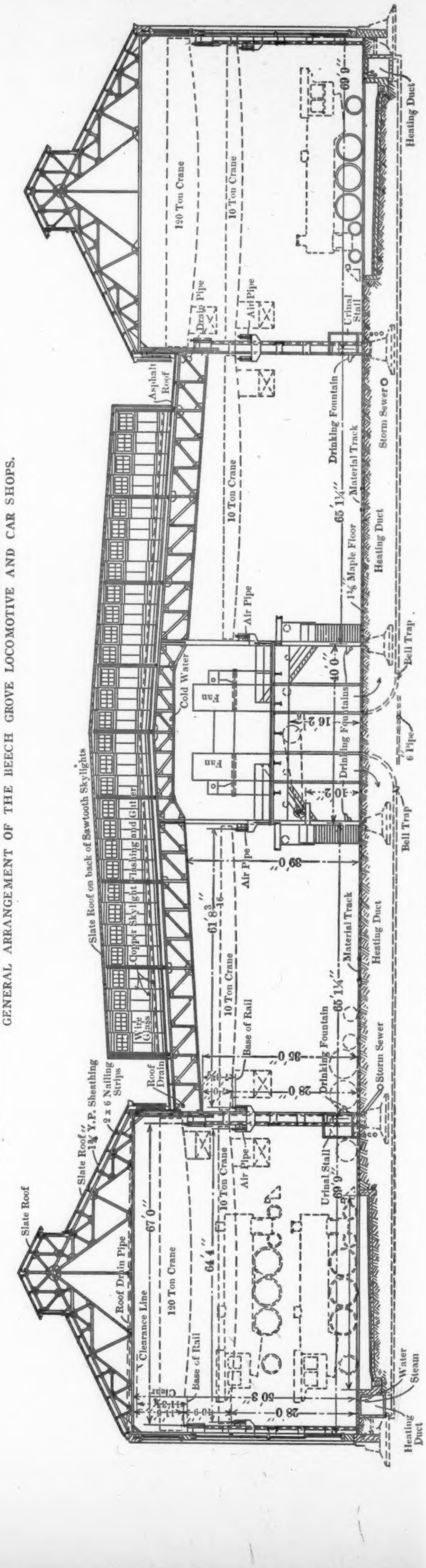
* Other articles on forging at the Collinwood shops may be found on page 142 of the April, 1906, issue; page 234, June, 1906; page 192, May, 1907, and page 344, September, 1907. Machine forging at the South Louisville shops of the Louisville & Nashville Railroad was described on page 125, April, 1907; at the Topeka shops of the Santa Fe, page 463, December, 1906; at the St. Paul shops of the Gt. Northern Railway, page 222, June, 1908.

STEEL PASSENGER CARS.—The use of steel in passenger car construction is not an experiment, but a matter of daily use. It lends itself readily to the skill of the artisan and reduces risk of serious accident to the passengers. It is more available than wood, produces a plainer effect, is easy to clean and weighs no more than a wooden coach if economically designed. The initial cost per passenger carried is about the same as for wooden coaches, its maintenance considerably less. The life of a coach is greatly increased by the use of steel, and damage suits as well as suffering in case of accident greatly reduced. The use of steel in coach construction is increasing daily and is here to stay.—*John McE. Ames before the Central Railway Club.*

COST OF DROP TABLES.—In regard to the cost of the drop table, that varies from the smaller 24 ft. table, which is for trailer wheels, front or rear drivers or engine and tender trucks, costing about $8,000.00, to the large ones for a whole locomotive, which cost about $11,000.00.—*Wm. Elmer before the Railway Club of Pittsburgh.*



GENERAL ARRANGEMENT OF THE BEECH GROVE LOCOMOTIVE AND CAR SHOPS.



CROSS-SECTION THROUGH MACHINE AND ERECTING SHOP—BEECH GROVE, BIG FOUR SYSTEM.

A STUDY OF THE GENERAL ARRANGEMENT OF THE BEECH GROVE SHOPS.

C. C. C. & St. L. Ry. (Big-Four).

The arrangement of the Beech Grove shops of the Big-Four is of special interest because, like the East Moline shops of the Rock Island System, there were no restrictions as to the shape and arrangement of the buildings. Every detail was carefully studied out and it may therefore be regarded as an ideal layout for the conditions for which it is intended. The buildings are all arranged so that they may be considerably enlarged in the future.

Indianapolis is the central and most important point of the Big-Four system; six divisions radiate from it. Beech Grove is about six miles from Indianapolis on the Chicago division. The new shops replace those at Brightwood, also near Indianapolis, but which were built a number of years ago and were not adapted for handling the new and larger power which has come into use since that time. The Big-Four has several other shops, most of which are not fitted for taking care of the heavier locomotives, and the Beech Grove shops, in addition to repairing the locomotives for the six divisions leading out of Indianapolis, will take care of the heavier power of the entire system and also do all of the manufacturing work for the system.

It is proposed to build a large concentration freight yard near Indianapolis and the new shop plant is located opposite the junction of the east and west bound classification yards of this yard. As may be seen from the general plan, provision has been made for repairing freight and passenger cars, as well as locomotives. When the new freight yards are installed it will be necessary to build a roundhouse which will probably be located north of the western part of the plant.

At present only the power house, store house and the machine and erecting, forge and boiler shops have been erected. These have been in operation for about six months. The car repair work is still done at Brightwood but will be transferred to Beech Grove as soon as conditions allow of the completion of the new plant.

Convenient handling of material and its steady progress from the raw to the finished state, and its application to the car or locomotive, have been carefully studied. The ten-ton yard crane extending from the end of the boiler shop to the end of the coach paint shop, about 2,000 ft., and the system of industrial tracks are important features in this connection. The lumber is stored at the eastern end of the plant, from which it goes direct to the planing mill or, if it is to be dried, to the dry kiln and from there to the planing mill or the dry lumber shed. The planing mill is near the power house and also convenient to the freight car repair shop and yards, where most of the lumber is used and to which it is transported over the industrial tracks. The coach shop is equally convenient to the planing mill. The small amount of lumber required for cabs and pilots may easily be delivered by the yard crane and over the industrial track extending from it to the cab and pilot shop. The cabinet shop willl be placed on the second floor of the planing mill.

The wheel shop is close to the freight car repair yard where the greater number of the wheels and axles will be used. The coach shop and the paint shop, each 177 ft. wide and 442 ft. long, are served by a transfer table. The truck work will be handled in the northern end of the coach shop. These shops are wide enough to accommodate two coaches on each track and there is also room for a coach between the transfer table and the building. If necessary, the coaches may be stripped in this open space and the seats and brass work may be sent to the upholstering shop and the brass finishing room before the coach is taken into the shop. The finishing work on the coaches may also be done here, if necessary. This arrangement also places the coach shop a sufficient distance from the paint shop to minimize the danger should the latter catch fire. The northern end of the forge shop and the eastern part of the southern end are to be used for car work and manufacturing; the southwestern quarter will be used for locomotive work. It is thus equally convenient to the three departments where its product is mostly used—the locomotive shop, the coach shop and the freight car repair yard.

The power house is centrally located and is equipped with Westinghouse-Parsons steam turbines, direct connected to the generators. It has a boiler room 45 ft. 6 in. wide, a pump room 23 ft. wide and a turbine room 45 ft. 6 in. wide. The building is 176 ft. long.

The locomotives, coming in for repairs, enter the plant at the western end. The 85 ft. turntable, west of the locomotive shop, is used for turning the locomotives so that they may be headed in the proper direction in the erecting shop; it is also used in transporting the boilers from the erecting shop to the boiler shop, and the tenders to the tank shop. As may be seen from the cross sectional view, the machine and erecting shop is of the double banked type and has two main erecting bays and a central portion consisting of two spans of about 65 ft. each and one span 40 ft. wide, with a balcony above it on which the heating fans, lavatories, locker rooms, tin shop, etc., are placed. The roof above these three central bays is of saw-tooth construction. The building is 572 ft. long, consisting of 26 panels of 22 ft. each. There are 52 engine pits, four being used for ingress and egress and 48 for repair purposes. The erecting shops are equipped with 120-ton traveling cranes, with 10-ton cranes operating on run-ways underneath those of the main cranes. The two bays in the machine shop, where the heavier tools are placed, are served by 10-ton traveling cranes.

The boiler shop is entirely separated from the locomotive shop and is 122 ft. 4 in. wide and 561 ft. long and has a 30-ton crane over the main bay and a 10-ton crane over the smaller bay in which the machine tools are placed. The foundry is located so that it has plenty of room about it for the storage of material; it faces the store house platform. The material may either be shipped from this platform or distributed throughout the plant by the midway crane and over the industrial tracks. The pattern shop is located convenient to the foundry. Like the power house, the store house and offices are centrally located, but directly opposite and nearest to the locomotive shop where the greater part of the supplies are used. The storehouse building is 70 ft. wide and 260 ft. long inside; the first and second stories are used for storehouse purposes and the third floor for offices, laboratory, assembly rooms, apprentice school room, hospital room, etc.

The buildings have concrete foundations to the water table and are of structural steel with walls of Colonial shale brick, which is very hard and does not absorb moisture. The foundation footings are in most cases reinforced, thus saving a considerable amount of concrete. The buildings are lighted with Cooper-Hewitt lamps.

There are three sewerage systems; one of them, known as the high level, drains the water from the roofs of the buildings into a reservoir, furnishing a supply of soft water for the toilet rooms, and other purposes. In case the reservoir should overflow the water from the high level system may be diverted into what is known as the low level system, which carries off all the surface drainage. The third system, the sanitary sewer, empties into the septic tank. The 100,000 gallon steel tank near the power house is 115 ft. high and is supplied from three wells.

The piping from the power house to the various buildings is carried in a tunnel; the wiring is carried in conduits laid alongside the tunnel.

The Beech Grove locomotive shop is in some respects modeled after the new erecting shop at Mt. Carmel, built a few years ago; the semi-cross-section is quite similar, the Beech Grove shop being of the double banked type. The Beech Grove shops, including the layout, design of the buildings and the selection and arrangement of the equipment, was worked out by a committee from the New York Central Lines' mechanical department, of which William Garstang, superintendent of motive power of the Big-Four, was chairman. The other members of the committee were E. D. Bronner, superintendent of motive power of the Michigan Central, L. H. Turner, superintendent of motive power of the Pittsburgh & Lake Erie Railroad, R. T. Shea, general inspector of tools and machinery of the New York Central Lines, F. M. Whyte, general mechanical engineer of the New York Central Lines and B. D. Lockwood, mechanical engineer of the Big-Four. The committee originally included H. F. Ball, who during his service on the committee was superintendent of motive power of the Lake Shore & Michigan Southern Railway, and who after his appointment as vice-president of the American Locomotive Company was succeeded by Mr. Turner. The committee was assisted in working out the general details by the Arnold Company, who worked in immediate touch with the chairman of the committee and his mechanical engineer, who were constantly in direct touch with all of the details of the installation.

RAILROAD MACHINE SHOP PRACTICE.

SHOES AND WEDGES.

George J. Burns.

Having an expensive machine tool and being confident that it represented in efficiency what it must command in price, the writer took up the study of machine shop practice in locomotive repair shops, with a view of getting at a basis on which to guarantee an increased output at a decreased cost. Appreciating that the output of a superior machine may be offset by clumsy methods, the investigations included a comparative study of shop practices in order that the best methods might be recommended. So far the principal shops of thirty of the largest railroads have been visited and the data obtained have been compiled and classified.

While the observations are of great value to the machine tool builder they are of even greater value to the railroads. The unnecessarily wide range in time and cost for doing the same work on similar machines in different shops is amazing. Nearly every shop has some superior methods, but some methods in every shop can be improved upon. Each shop should profit by the aggregate brains and combined experience of all. Co-operation through some common medium of analysis and comparison would bring about a revolution in the cost of repairs.

Aside from the skill of the operator in manipulating the machine after it is in actual operation, the output is limited by its speed and power capacity, and by the method and order of handling, setting and holding the work. The former can be increased only by superior mechanism, while in the latter there is usually great room for improvement. As the machine produces only while in operation, every gain in the time of handling the work is clear profit. Many shops are employing, or have employed shop economists, and nearly all have speed or efficiency men. No one man can possess the combined experience of all. Experimenting is expensive. What is required is direct specific knowledge of what are the best results and how they are being accomplished. Observation is the best teacher, and results are the most conclusive demonstration.

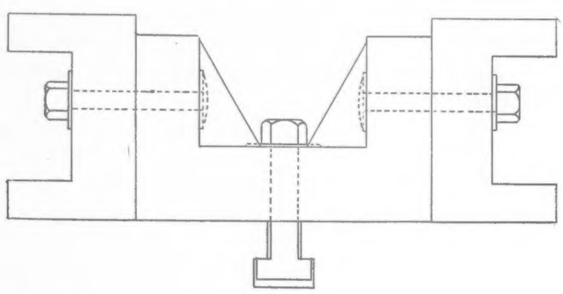


FIG.2

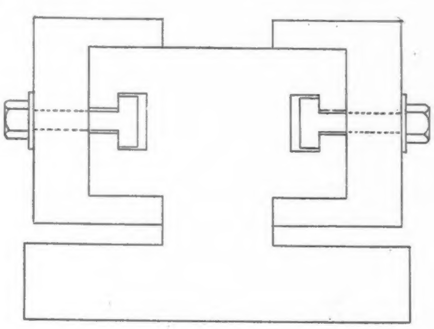


FIG.4

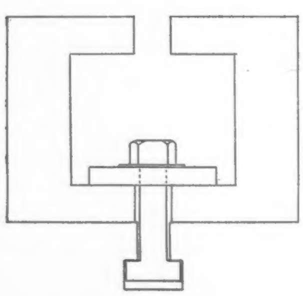


FIG.1

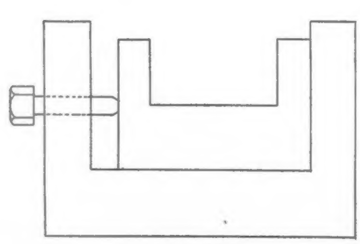


FIG.3

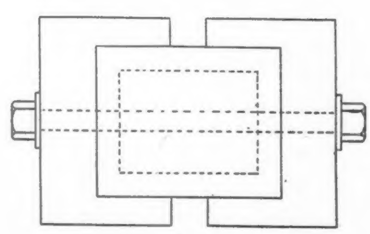


FIG.5

MACHINING SHOES AND WEDGES.

Shoes and Wedges.

Material.—Most roads use cast iron shoes and wedges; a few are using bronze, and one is using cast iron with a bronze facing. The use of bronze for locomotive parts is decidedly on the increase, but as the subject of material is not immediately pertinent to the purpose of these articles the comparative advantages of different materials will not be considered. It may be noted, however, that most tools on which bronze is machined are not running at speeds at which the metal can be cut most efficiently.

Preparing Shoes and Wedges.—Most shops limit the preparing of shoes and wedges to the sides and the frame fit. The practice seems to indicate that anything more than that is an unnecessary expense. Shops that finish faces or edges argue that it assists in getting a square job. The value of that contention seems to be limited to practice where the frame fit is the last process in preparing.

The most common practice seems to be the least efficient. The pieces are usually set up on the sides in parallel rows, as shown

in Fig. 1. One shop bolts the pieces to an angle, as shown in Fig. 2. Where machining the sides is the first process the pieces are chucked for frame fit as shown in Fig. 3. Another shop bolts the pieces down on the faces and planes the sides with the rail tool on the down feed. The last practice seems to be the least efficient, as there is a tendency for the tool to crowd out, often necessitating a second cut.

In preparing shoes and wedges the order of processes that seems to give the best results in output and cost is to finish the frame fit first. It is good planer and milling machine practice to start, when practical, by setting the piece on its broadest base, in which position it can be held most securely. The frame fit having been machined, the pieces are bolted to a jig for side planing or milling. This secures a quick setting, a secure hold and a square job. (See Figs. 4 and 5.)

The jig shown in Fig. 5 is removable; the operator fastens the pieces on one set of jigs while he is planing the other set.

The most common practice, and seemingly the best, in making the frame fit is to plane down the sides with a double point, or broad forming tool. Some shops have abandoned this method because of liability of breaking the tool. This can be overcome by blocking the tool to prevent it from rising on the return stroke. One shop that prepares shoes and wedges on milling machines runs two machines side by side with an operator and helper, each assisting the other in setting the work. Results, however, do not show as much efficiency as is secured by use of the jig (Fig. 4).

Cost of Preparing Shoes and Wedges.—Cost runs all the way from 15 cents to 64 cents, the most common cost being about 30 cents. The lowest cost observed was 15 cents on a planer, and included face and edges, but it was manufacturing work, and cannot be fairly compared to repair work, which in most shops is necessarily more or less intermittent. On a powerful milling machine the piece price was 20 cents and included faces and edges. The piece price of work done on the jig, shown in Fig. 5, was 20 cents, which includes planing the edges of the shoes; this is done on a slow planer, running much below the speed capacity of the steel. On a modern high speed planer the piece price on this process can be materially reduced.

Replaning or Fitting Shoes and Wedges.—This work is done on planers and shapers. The average time required is from 15 minutes in some shops to one hour in others, and the piece price varies from 8 to 35 cents, the usual cost being about 20 cents.

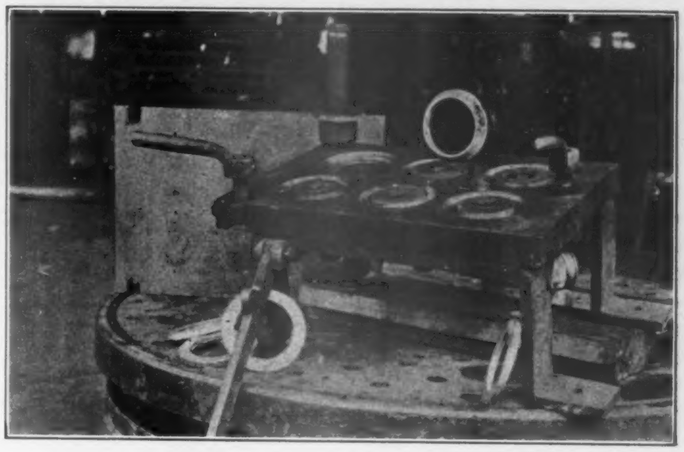
The average cost of the shoe and wedge work in a shop depends largely upon the proportion of new work. The shortest time and the lowest cost can be obtained only by a tool of superior efficiency. The amount of reduction is frequently more than one inch, and the material, as a rule, is very difficult to cut. Some shops line up old shoes and wedges when they become thin, but whether this pays depends upon the cost of preparing the new ones.

PHOTOGRAPHING MACHINERY.—In photographing machinery the lens should be of long focus; never shorter than the diagonal of the sensitive plate. The machinery should be painted a "flat" drab color, parts in shadow being painted a lighter shade than more prominent parts. Light should come from one direction only, and at a downward angle of about 20 degrees from the horizontal. In focusing, the points of sharpest focus should be midway between the center and the edges of the ground glass. No matter how much the camera is pointed up or down, the ground glass should always be vertical. Exposure should be ample; an under-exposed plate can never show what the light has never recorded upon it.—*S. Ashton Hand, before the Amer. Soc. Mech. Engrs.*

FEED OF A PLANING MACHINE.—The rate of feed is an important factor in determining the life of a knife edge on a planing cutter. It is, of course, dependent upon the lumber, the class of work desired, etc., but it should never be less than eight knife marks per inch and never finer than 16 knife cuts per inch.

MOULDING PACKING RINGS.

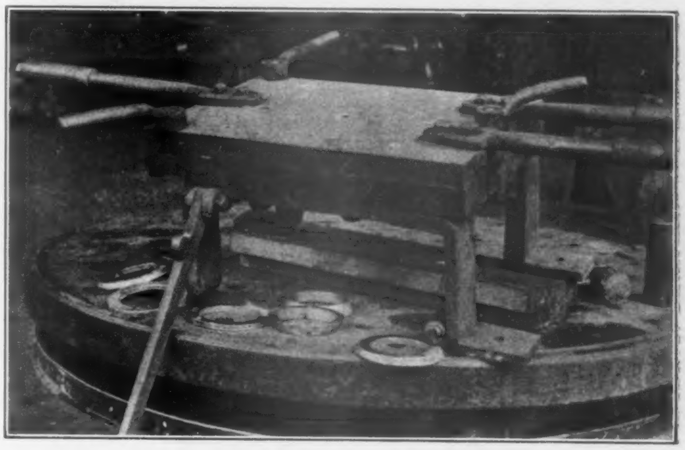
United States metallic packing rings for piston and valve stem packing are moulded at the McKees Rocks shops of the Pittsburgh & Lake Erie Railroad so as not to require machining; they are steam tight and satisfactory in every respect. The moulds are of cast iron and are shown in the accompanying illustrations. The contour of that part of the ring which fits the stuffing box is, of course, the same for all the engines; to provide for the variation in the diameter of the rod that part of the mould for



MOULD FOR PACKING RINGS.

the inner side of the ring is removable and a sufficient number of these removable parts are carried to provide the necessary variety of diameters.

When the plugs or inner parts have been adjusted the top of the mould is put in place, as shown in the second illustration. It is locked by the three clamps; the metal is poured in the larger holes, the air escaping through a set of smaller ones. The three clamps are then loosened, the two at the left-hand end dropping downward out of the way. The lever near the left is



PACKING RING MOULD, READY TO POUR.

lifted and the lug on it strikes the top plate of the mould, moving it backward and cutting off the sprues. The cover is then lifted off and the rings are removed and are ready for application to the locomotive. To use such a mould successfully the packing metal must be carefully selected. Most metals do not seem to flow freely enough to fill the entire space and the Lake Erie officials have only found one or two metals which are satisfactory for this purpose.

PROTECTION OF RAILROAD MEN.—I am strongly convinced that the government should make itself as responsible to employees injured in its employ as an interstate railroad is made responsible by federal law to its employees, and I shall be glad, whenever any additional reasonable safety device can be invented to reduce the loss of life and limb among railway employees, to urge Congress to require its adoption by interstate railways.—*Inaugural Address of President Taft.*

THE DESIGN OF MILLING CUTTERS.

C. J. Morrison.

The high initial cost of the alloy or high speed steels necessitates the use of extreme care in the design and manufacture of tools of these metals. A few spoiled or inefficiently designed tools will soon eliminate the saving in labor charges which should result from the use of tools made of alloy steel. This applies more directly to milling cutters than to any of the other tools. The average railroad machinist or toolmaker has had very little experience in designing and making milling cutters that will cut freely and not chatter. Yet the milling machine is so intimately associated with the economical operation of a railroad shop that the proper design of cutters is extremely important. The economy obtained by the use of milling machines for work on driving boxes, shoes and wedges, eccentrics, crossheads, rods, etc., is well understood, but, at the same time, many milling machines have been condemned for such work largely on account of the poor design of cutters.

General practice, under necessity of economy of manufacture and grinding, has placed milling cutters in two distinct classes, known as solid and inserted teeth. Under solid cutters are usually included all cutters under six inches in diameter. This type of cutter is used for milling flutes of reamers and taps and for general work where small sizes are best adapted. Under inserted teeth cutters, are included all cutters over six inches in diameter. This type is used for facing, side cutting and other special and general work. It is not considered practicable to make inserted teeth cutters under six inches in diameter. The blank for these cutters should, in all cases, be made of soft steel.

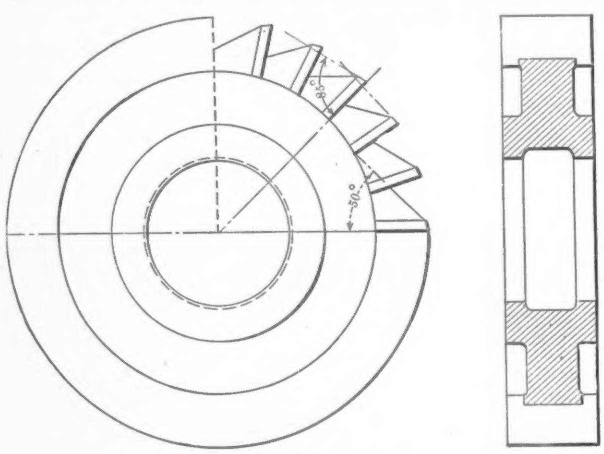


FIG. 1.—SOLID MILLING CUTTER.

Solid Cutters.—The number of cutting edges for solid milling cutters, intended for general work, has been taken in average practice as follows:

Diameter of Cutter.	No. Cutting Edges.
½"	6
¾"	8
1"	12
1¼"	14
1½"	16
2"	18
2½"	21
3"	24
3½"	26
4"	28
5"	30
6"	32

In most cases the cutting edge is made with a radial face, as indicated by dotted lines in Fig. 1. The spaces may be cut with a tool that will produce an angle of 50 degrees between the face and the back of the tooth. This angle gives ample depth to the clearance space, and at the same time furnishes well supported cutting edges. The milling machine cutter used for forming the teeth is run in deep enough to leave the lands .09 to .1 in. in width, according to the size of the cutter being made. The teeth are also cut on the sides of the cutter, as shown in Fig. 1. The spaces here may be cut with a milling cutter that will produce an angle of from 60 to 70 degrees between the face and the back of the tooth. When milling the teeth on the side the index head cannot be left at the 90 degree mark or on the zero mark, but must be inclined a little, in order that the cutter may make the lands of equal width. The amount the index head is to be inclined depends upon such varying conditions that computation of it is a very difficult problem, and in practice it is more easily found by trial.

After cutting the teeth, remove all burrs by filing, and then harden. In order to grind a high speed alloy cutter, it is first circularly ground, then backed off for clearance. It is essential that great care be taken not to draw the color on the cutting edge, as this tends to soften it. Alloy steel is air hardening, but nevertheless experience has shown that with any of these cutters that have been drawn, it is impossible to get as good results as with one that has been more carefully handled, and the color of which has not been drawn. Alloy cutters should preferably be ground dry, but not too viciously. If water is used, the supply should be plentiful, as sprinkling the cutters creates surface cracks. The reason for this is that the tungsten in the steel tends to adhere to the cutting edges and fill up the pores of the grinding wheel, thereby glazing the surface of the wheel, and causing the rapid heating of the piece being ground.

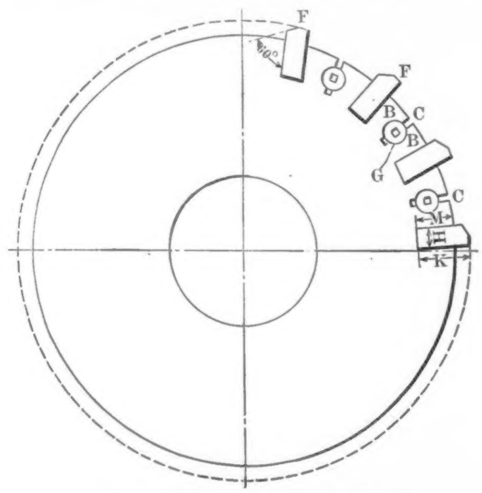


FIG. 3.—INSERTED TEETH CUTTER.

Helical Milling Cutters.—When making solid helical milling cutters, more commonly known as spiral milling cutters, choose the helix that will give the cutting edge an angle of about 20 degrees to a plane passing through the axis of the cutter. It does not make any particular difference whether the helix is left-handed or right-handed, when the cutter is intended for a machine on which the cutter arbor is supported at the end. However, when used for a machine on which the end of the arbor is free, the helix should be such that the tendency will be to force the arbor home; that is, if the cutter is left-handed, the helix should be right-handed. A right-handed helix is one that in advancing, turns in the direction of the hands of a clock; a left-handed helix turns in the opposite direction. A left-handed cutter is one that travels in the direction of the clock, when viewed from the front of the machine and looking towards the spindle, and a right-handed cutter is one that travels opposite to the hands of a clock.

For heavy milling a style of cutter with nicked teeth is recommended, as the nicks break up the chips, thereby enabling a heavier cut to be taken than is practicable with a cutter with a continuous cutting edge. These nicks, in the ordinary cutter, are ⅜ in. long by ⅛ in. deep and 1¼ in. from center to center on

surface cutters under 6 in. in diameter; on surface cutters above 6 in. in diameter the nicks are ½ in. long by 3/16 in. deep and 1½ in. from center to center. These nicks are milled in rows around the circumference, a row consisting in alternate nicks and teeth, as shown on the cutter in Fig. 2, a row always extending around the edge of a cutter, as "AA," Fig. 2, thus eliminating breakage of teeth.

In the manufacture of inserted teeth cutters there are many ways of holding the blades in the body. The one outlined in Fig. 3 is adapted for medium sized cutters for all general work,

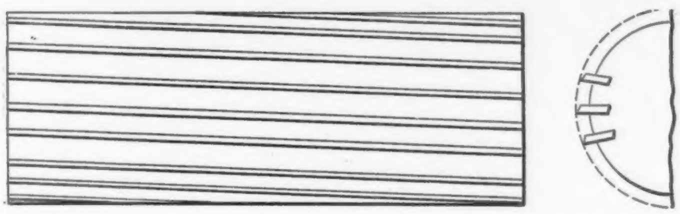


FIG. 5.—BLADES ARE TO BE MILLED TO THE LINES OF A HELIX.

and is a design furnished by many manufacturers. The metal between every pair of slots, as "BB," Fig. 3, is slotted with a narrow slot, "C." Before cutting these slots, a hole is drilled and reamed taper to receive the taper pin, "G," which is driven in after the cutter, "F," is in place, thus holding the blades frictionally. Driving the taper pin out loosens the cutter sufficiently to allow it to be easily withdrawn. In the case of very long

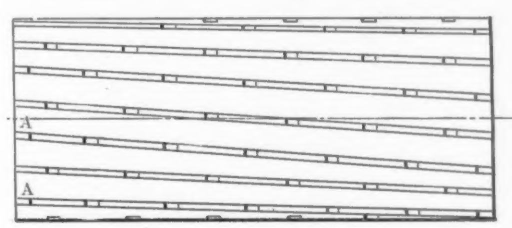


FIG. 2.—MILLING CUTTER WITH NICKED TEETH.

cutters, this method is not used, but the cutters are dovetailed in and the back of the cutting edge is then caulked.

Inserted milling cutters may be given a helical cutting edge for the same purpose that solid cutters are provided with it, but if a helical slot is cut in the body the cutting tool will have to be helical in order to fit. This is very hard to make, however, and cannot successfully be made with the machinery found in the average tool room. For this reason straight slots are cut at an angle which will vary with the length of the cutter. In no case should this angle be so small that when one blade leaves the work, the other is not engaged in cutting.

Straight cutters are universally used. Straight cutters set at an angle are open to one objection, which is that the front face of the cutter is not radial throughout its length, but changes from front rake at one end to radial face at about the center, and to negative rake at the other end. This is illustrated in Fig. 4, which shows one straight cutter inserted at an angle. In order to bring out the objectionable feature more clearly, the body has been made rather small. At the end, "A," the face of the cutting edge has front rake, as indicated by radial line "OC;" the cutting edge radial line changes to a negative rake at "F," as shown by "OE."

The best way to relieve this defect is to mill the cutting face helical with a suitable cutter set to produce a radial face. This is shown in Fig. 5. In order to allow this to be done the blades are made heavier in large cutters, being as much as one-half inch thick. Before cutting the slots at an angle, select a helix that will give an angle of about 5 degrees, with a plane passing through the axis. Gear the milling machine to cut this line and turn the blank body in the machine. With a scriber clamped to the milling machine arbor, scribe a helical line on the face of the body; this line will then serve as a guide for setting the index head by trial to the angle that will give straight slots coinciding closely with the helix.

If a milling machine is not so arranged that the index head swivels on the platen, the slots will have to be cut with an end mill. Where the mill has a so-called raising block, to which the index head may be clamped and then swiveled across the platen, the slots can be cut with a regular axial cutter. After the cutters have been inserted into the slots, and locked, the milling machine is geared again for the proper helix, and the cutting face of each cutter is milled helical and radial. The number of cutting edges for milling cutters with inserted blades may be as given below, which is good average practice:

TABLE OF CUTTING EDGES FOR MILLS WITH INSERTED CUTTERS.

Diameter.	Number.	Diameter.	Number.
6	12	18	35
7	14	20	38
8	16	22	41
9	18	24	44
10	20	26	46
12	24	28	48
14	28	30	50
16	32	32	52

The proportions of the cutters may be about as follows: (See Fig. 3.) The thickness of the cutter may be about one-fourth the distance from one cutting edge to the next one. The depth "K" may be about .75 of the pitch of the cutting edges, and the depth "M" of the slots may be about .55 of the pitch. By pitch here is meant the distance from one cutting edge to the other measured along the arc of the circle circumscribed about the

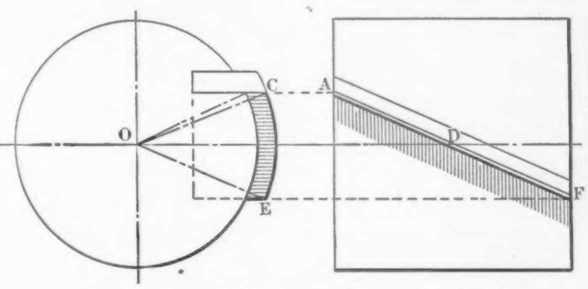


FIG. 4.—STRAIGHT BLADE SET AT AN ANGLE.

cutter, or in other words the pitch of the cutting edges is equal to the circumference of the cutter divided by the number of teeth. The cutters may be backed off with a milling cutter that will give an angle of about 60 degrees between the front and top of the cutter, as shown in the figure. The backing off may be carried forward far enough to leave a land of about .03 inches. After the cutters have been thus formed and shaped, they are

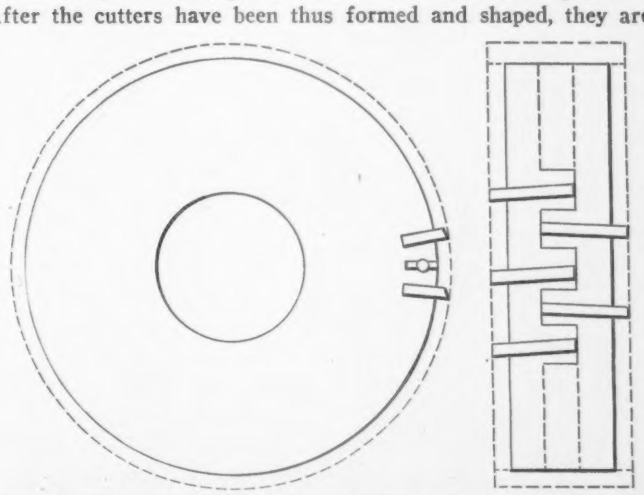


FIG. 6.—INSERTED TOOTH CUTTER WHICH MAY BE ADJUSTED FOR WIDTH.

driven out and hardened in the regular way of hardening alloy steel, and are then put in the slots and circularly ground and given a relief of about 5 degrees, in place of the old practice of 3 degrees which was generally used with the carbon steel.

A type of cutter known as the expanding inserted milling cutter is extremely useful in milling shoes and wedges, in that

the body of the cutter is adjustable in width. Two distinct sets of blades are set in two separate bodies at an angle of 4 degrees from the axial line and with the cutting edges slanting inward. The two bodies interlock and by placing liners between them a variation of about 3/16 in. can be obtained in the width of the mill; this allows 3/32 in. to be ground off before resetting the blades, and at the same time lowers the labor cost in resetting the blades, and increases the life of a cutter. Such a cutter is shown in Fig. 6.

Adherence to the practices as here outlined will provide efficient milling cutters at low cost, which produce the large output of work required by modern shops.

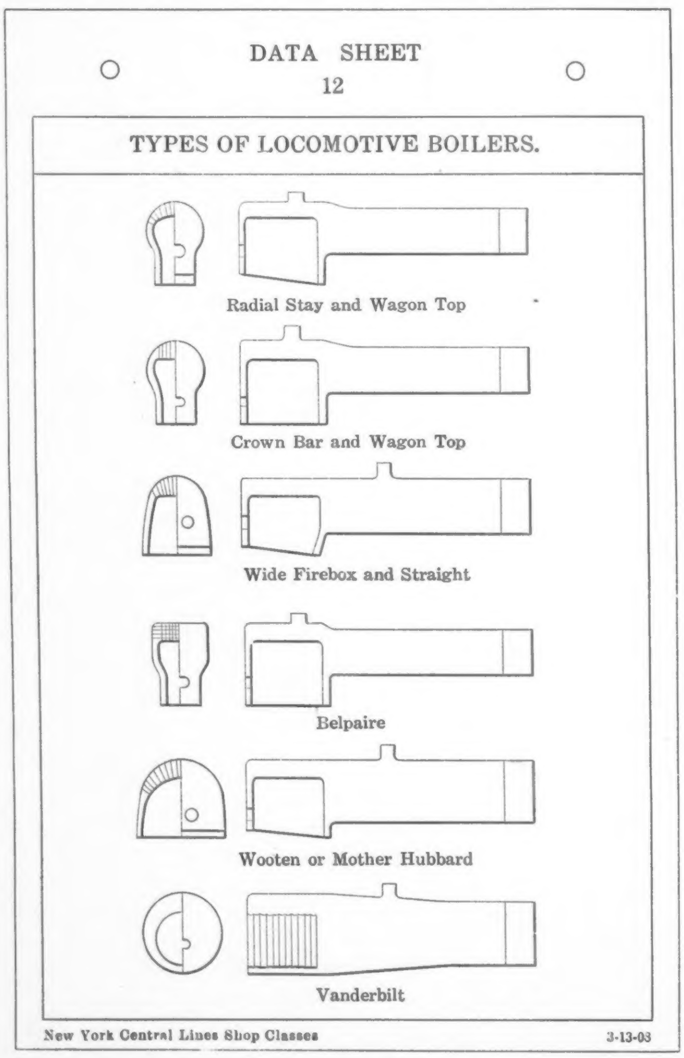
THE RAILROAD SHOP APPRENTICE.

NEW YORK CENTRAL LINES.

A form of instruction which appeals to the boys and is giving very satisfactory results has recently been introduced in the school room. Large blueprints, showing sections and elevations of locomotive boilers, are spread out upon a table and one or two boys, working together, fill in on suitably prepared blanks all of the information called for. These forms include information such as ordinarily appears in a specification or bill of material, and are written in such language and terms as may be easily comprehended by the apprentices. Some of the questions require a long hunt before the answer is found. The boys know it is somewhere on the print and do not give up until it is found.

* * * * * * *

As a bonus for performing certain amounts of home study, as indicated by the number of problem sheets which are turned in, data sheets containing rules, formula, tables and sketches are issued to the boys in blueprint form. One of these sheets is reproduced herewith. The practice at one shop is to give a data sheet to the apprentice for every ten consecutive sheets of home arithmetic work which he turns in. To be useful the data sheets must be simple and applicable to features with which the apprentice comes in direct contact in connection with his work.



TYPICAL DATA SHEET FOR APPRENTICES.

* * * * * * *

Sketching is being emphasized more and more strongly. Each apprentice on the system has recently been furnished with a sketch book, soft pencil and two-foot rule.

The successful mechanic must understand mechanical drawing, but even more important is the ability to quickly sketch an object or put practical ideas on paper intelligently, without the drawing-board and T square.

* * * * * * *

It has been found necessary to set an arbitrary educational standard for boys enrolling as apprentices. So many boys who are not fully qualified wish to enter the schools that an entrance examination has been adopted; failure to pass this requires the boy to wait and study until he can do so. One or two boys below the standard can very greatly lower the standing of a whole class.

* * * * * * *

Harper's Weekly has been running a series of articles entitled "This Land of Opportunity." One of these was given over to a consideration of the New York Central Lines apprenticeship system, from which the following extract has been taken:

"It is required from the boy, in order not to take too much from his shop time, that he shall do a considerable part of these problems at home. With only the rarest exceptions, this work is prosecuted faithfully and well. When it isn't, something drops. Your delinquent student in this college goes up before a faculty consisting of a division foreman in whose sight he is a very negligible unit.

"I am informed," said this Nemesis to a boy in the West Albany shop school a little while ago, "that you haven't been working out the problems given to you, and that you're away behind."

"Yes, sir; I guess that's right."

"Well, you've got just one more chance. Work 'em or go get your time."

At shop time next morning the backslider walked up with a handful of problem papers, and all were solved.

"All these?" said the faculty, in surprise, "when did you do 'em?"

"Last night."

"H'm! It must have taken some time."

"It took all night. I haven't been to bed."

And having "worked off his condition," he went back to his job in the shops and put in a full day.

That is a fair sample of the school discipline and the way it works.

* * * * * * *

There are now ten apprentice schools on the New York Central Lines with a total of 547 apprentices. It is expected that two more schools will soon be opened.

EQUIPMENT OF THE C. P. R.—It is reported that Sir T. Shaughnessy has written a letter to Sir Wilfrid Laurier pointing out that during the years 1902 to 1908 the Canadian Pacific Railway has added to its rolling stock at the rate of fourteen freight cars every day, one passenger car every two days, and one locomotive every three days; and yet such is the volume of traffic that passes over this system that it has the utmost difficulty in keeping pace with the demand made upon it. It has been calculated that the combined freight cars on the Canadian Pacific Railway have a deadweight capacity equivalent to the weight of the entire population of England.

ENGINEERING DATA—TUBES

From a hand-book on "The Mechanical Properties of Shelby Seamless Steel Tubing"; prepared by Prof. Reid T. Stewart. Published and copyrighted in 1908 by the National Tube Company of Pittsburgh, Pa., through whose courtesy we are enabled to present this data.

TABLE 3

Inside Surface in Square Feet Per Lineal Foot For Shelby Standard Cold Drawn Mechanical Tubing

Reid T. Stewart and R. L. W., 1907. Chkd. by W. F. F.

Outside Diam. Inches	THICKNESS IN GAGE AND FRACTIONS OF AN INCH																
	22 BWG	20 BWG	18 BWG	1/16	3/32	1/8	5/32	3/16	7/32	1/4	5/16	3/8	1/2	5/8	3/4	7/8	1
1/2	.1162	.1126	.1052	.0982	.0818	.0654											
5/8	.1490	.1453	.1380	.1309	.1145	.0982											
3/4	.1817	.1780	.1707	.1636	.1473	.1309	.1145	.0982									
7/8	.2144	.2107	.2034	.1963	.1800	.1636	.1473	.1309	.1145								
1	.2471	.2435	.2361	.2291	.2127	.1963	.1800	.1636	.1473	.1309							
1 1/8	.2799	.2762	.2689	.2618	.2454	.2291	.2127	.1963	.1800	.1636							
1 1/4	.3126	.3089	.3016	.2945	.2782	.2618	.2454	.2291	.2127	.1963	.1636	.1309					
1 3/8	.....	.3416	.3343	.3272	.3109	.2945	.2782	.2618	.2454	.2291	.1963	.1636					
1 1/2	.....	.3744	.3670	.3600	.3436	.3272	.3109	.2945	.2782	.2618	.2291	.1963	.1309				
1 3/4	.....	.....	.....	.4254	.4091	.3927	.3763	.3600	.3436	.3272	.2945	.2618	.1963				
2	.....	.....	.....	.4909	.4745	.4581	.4418	.4254	.4091	.3927	.3600	.3272	.2618	.1963			
2 1/4	.....	.....	.....	.5563	.5400	.5236	.5072	.4909	.4745	.4581	.4254	.3927	.3272	.2618			
2 1/2	.....	.....	.....	.6218	.6054	.5890	.5727	.5563	.5400	.5236	.4909	.4581	.3927	.3272			
2 3/4	.....	.....	.....	.6872	.6709	.6545	.6381	.6218	.6054	.5890	.5563	.5236	.4581	.3927			
3	.....	.....	.....	.....	.7363	.7199	.7036	.6872	.6709	.6545	.6218	.5890	.5236	.4581	.3927	.3272	.2618
3 1/4	.....	.....	.....	.....	.8018	.7854	.7690	.7527	.7363	.7199	.6872	.6545	.5890	.5236	.4581	.3927	.3272
3 1/2	.....	.....	.....	.....	.8672	.8508	.8345	.8181	.8018	.7854	.7527	.7199	.6545	.5890	.5236	.4581	.3927
3 3/4	.....	.....	.....	.....	.....	.9163	.8999	.8836	.8672	.8508	.8181	.7854	.7199	.6545	.5890	.5236	.4581
4	.....	.....	.....	.....	.....	.9817	.9654	.9490	.9327	.9163	.8836	.8508	.7854	.7199	.6545	.5890	.5236
4 1/4	.....	.....	.....	.....	.....	.....	1.0308	1.0145	.9981	.9817	.9490	.9163	.8508	.7854	.7199	.6545	.5890
4 1/2	.....	.....	.....	.....	.....	.....	1.0963	1.0799	1.0636	1.0472	1.0145	.9817	.9163	.8508	.7854	.7199	.6545
4 3/4	.....	.....	.....	.....	.....	.....	1.1617	1.1454	1.1290	1.1126	1.0799	1.0472	.9817	.9163	.8508	.7854	.7199
5	.....	.....	.....	.....	.....	.....	1.2272	1.2108	1.1945	1.1781	1.1454	1.1126	1.0472	.9817	.9163	.8508	.7854
5 1/2	.....	.....	.....	.....	.....	.....	1.3581	1.3417	1.3254	1.3090	1.2763	1.2435	1.1781	1.1126	1.0472	.9817	.9163

TABLE 6

Capacity in Cubic Inches Per Lineal Foot For Shelby Standard Cold Drawn Mechanical Tubing

Reid T. Stewart and R. L. W., 1907. Chkd. by W. F. F.

Outside Diam. Inches	THICKNESS IN GAGE AND FRACTIONS OF AN INCH																
	22 BWG	20 BWG	18 BWG	1/16	3/32	1/8	5/32	3/16	7/32	1/4	5/16	3/8	1/2	5/8	3/4	7/8	1
1/2	1.858	1.743	1.523	1.325	.920	.589											
5/8	3.051	2.903	2.618	2.356	1.804	1.325											
3/4	4.539	4.358	4.007	3.682	2.982	2.356	1.804	1.325									
7/8	6.322	6.107	5.690	5.301	4.455	3.682	2.982	2.356	1.804								
1	8.399	8.151	7.668	7.216	6.222	5.301	4.455	3.682	2.982	2.356							
1 1/8	10.770	10.490	9.941	9.425	8.283	7.216	6.222	5.301	4.455	3.682							
1 1/4	13.436	13.123	12.508	11.93	10.64	9.425	8.283	7.216	6.222	5.301	3.682	2.356					
1 3/8		16.051	15.37	14.73	13.29	11.93	10.64	9.425	8.283	7.216	5.301	3.682					
1 1/2	.....	19.273	18.53	17.82	16.24	14.73	13.29	11.93	10.64	9.425	7.216	5.301	2.356				
1 3/4	.....	.....	.....	24.89	23.01	21.21	19.48	17.82	16.24	14.73	11.93	9.425	5.301				
2	.....	.....	.....	33.13	30.96	28.86	26.84	24.89	23.01	21.21	17.82	14.73	9.425	5.301			
2 1/4	.....	.....	.....	42.56	40.09	37.70	35.38	33.13	30.96	28.86	24.89	21.21	14.73	9.425			
2 1/2	.....	.....	.....	53.16	50.40	47.71	45.10	42.56	40.09	37.70	33.13	28.86	21.21	14.73			
2 3/4	.....	.....	.....	64.94	61.89	58.90	56.00	53.16	50.40	47.71	42.56	37.70	28.86	21.21			
3	.....	.....	.....	.....	74.55	71.27	68.07	64.94	61.89	58.90	53.16	47.71	37.70	28.86	21.21	14.73	9.425
3 1/4	.....	.....	.....	.....	88.39	84.82	81.33	77.90	74.55	71.27	64.94	58.90	47.71	37.70	28.86	21.21	14.73
3 1/2	.....	.....	.....	.....	103.41	99.55	95.76	92.04	88.39	84.82	77.90	71.27	58.90	47.71	37.70	28.86	21.21
3 3/4	.....	.....	.....	.....	.....	115.45	111.37	107.35	103.41	99.55	92.04	84.82	71.27	58.90	47.71	37.70	28.86
4	.....	.....	.....	.....	.....	132.54	128.15	123.85	119.61	115.45	107.35	99.55	84.82	71.27	58.90	47.71	37.70
4 1/4	.....	.....	.....	.....	.....	.....	146.12	141.52	136.99	132.54	123.85	115.45	99.55	84.82	71.27	58.90	47.71
4 1/2	.....	.....	.....	.....	.....	.....	165.26	160.37	155.55	150.80	141.52	132.54	115.45	99.55	84.82	71.27	58.90
4 3/4	.....	...	.....	.....	.....	.....	185.59	180.40	175.28	170.24	160.37	150.80	132.54	115.45	99.55	84.82	71.27
5	.....	.....	.....	.....	.....	.....	207.09	201.60	196.19	190.85	180.40	170.24	150.80	132.54	115.45	99.55	84.82
5 1/2	.....	.....	.....	.....	.....	.....	253.62	247.55	241.55	235.62	223.99	212.65	190.85	170.24	150.80	132.54	115.45

TABLE 5

Weight in Pounds Per Lineal Foot For Shelby Standard Cold Drawn Mechanical Tubing

Based on wt. 1 cu. in. Steel=0.2833 lb. Reid T. Stewart and R. L. W., 1907. Chkd. by W. F. F.

Outside Diam. Inches	THICKNESS IN GAGE AND FRACTIONS OF AN INCH																
	22 BWG	20 BWG	18 BWG	1/16	3/32	1/8	5/32	3/16	7/32	1/4	5/16	3/8	1/2	5/8	3/4	7/8	1
1/2	.141	.174	.236	.292	.407	.501											
5/8	.179	.221	.301	.375	.532	.668											
3/4	.216	.267	.367	.459	.657	.834	.991	1.13									
7/8	.253	.314	.432	.542	.782	1.00	1.20	1.38	1.53								
1	.291	.361	.498	.626	.907	1.17	1.41	1.63	1.83	2.00							
1 1/8	.328	.407	.563	.709	1.03	1.34	1.62	1.88	2.12	2.34							
1 1/4	.365	.454	.629	.793	1.16	1.50	1.83	2.13	2.41	2.67	3.13	3.50					
1 3/8	.....	.501	.694	.876	1.28	1.67	2.03	2.38	2.70	3.00	3.55	4.01					
1 1/2	.....	.548	.759	.960	1.41	1.84	2.24	2.63	2.99	3.34	3.96	4.51	5.34				
1 3/4	.....	.....	.....	1.13	1.66	2.17	2.66	3.13	3.58	4.01	4.80	5.51	6.68				
2	.....	.....	.....	1.29	1.91	2.50	3.08	3.63	4.16	4.67	5.63	6.51	8.01	9.18			
2 1/4	.....	.....	.....	1.46	2.16	2.84	3.49	4.13	4.75	5.34	6.47	7.51	9.35	10.85			
2 1/2	.....	.....	.....	1.63	2.41	3.17	3.91	4.63	5.33	6.01	7.30	8.51	10.68	12.52			
2 3/4	.....	.....	.....	1.79	2.66	3.50	4.33	5.13	5.91	6.68	8.14	9.51	12.02	14.18			
3	.....	.....	.....	.....	2.91	3.84	4.75	5.63	6.50	7.34	8.97	10.51	13.35	15.85	18.02	19.86	21.36
3 1/4	.....	.....	.....	.....	3.16	4.17	5.16	6.13	7.08	8.01	9.80	11.51	14.69	17.52	20.03	22.19	24.03
3 1/2	.....	.....	.....	.....	3.41	4.51	5.58	6.63	7.67	8.68	10.64	12.52	16.02	19.19	22.03	24.53	26.70
3 3/4	.....	.....	.....	.....	.....	4.84	6.00	7.13	8.25	9.35	11.47	13.52	17.36	20.86	24.03	26.87	29.37
4	.....	.....	.....	.....	.....	5.17	6.41	7.63	8.83	10.01	12.31	14.52	18.69	22.53	26.03	29.20	32.04
4 1/4	.....	.....	.....	.....	.....	.....	6.83	8.14	9.42	10.68	13.14	15.52	20.03	24.20	28.04	31.54	34.71
4 1/2	.....	.....	.....	.....	.....	.....	7.25	8.64	10.00	11.35	13.98	16.52	21.36	25.87	30.04	33.88	37.38
4 3/4	.....	.....	.....	.....	.....	.....	7.67	9.14	10.59	12.02	14.81	17.52	22.70	27.53	32.04	36.21	40.05
5	.....	.....	.....	.....	.....	.....	8.08	9.64	11.17	12.68	15.64	18.52	24.03	29.20	34.04	38.55	42.72
5 1/2	.....	.....	.....	.....	.....	.....	8.92	10.64	12.34	14.02	17.31	20.53	26.70	32.54	38.05	43.22	48.06

PORTABLE VISE BENCH.

TRUCK FOR BOILER WASHING HOSE AND TOOLS.

PORTABLE STEEL TOOL BOX.

DEVICE FOR PULLING DOWN PEDESTAL BINDERS.

LABOR AND TIME SAVING DEVICES IN THE ROUND-HOUSE.

Pittsburgh & Lake Erie Railroad, McKees Rocks, Pa.

There is no place on a railroad where labor and time saving devices are so important as in the roundhouse. The foreman's ingenuity is taxed to the utmost to make every move count and to perform each operation in the shortest possible time. D. J. Redding, master mechanic of the Pittsburgh & Lake Erie Railroad, and president of the Railway Club of Pittsburgh, has suggested that a description of the best labor and time saving devices and methods used in roundhouses, selected from a number of different railroads, would prove of great benefit to those interested in this work. Following this suggestion several such devices have been selected from the McKees Rocks roundhouse of the Pittsburgh & Lake Erie Railroad and are described herewith. Our readers are urged to send us descriptions of tools, devices or methods, which they have found valuable in roundhouse work.

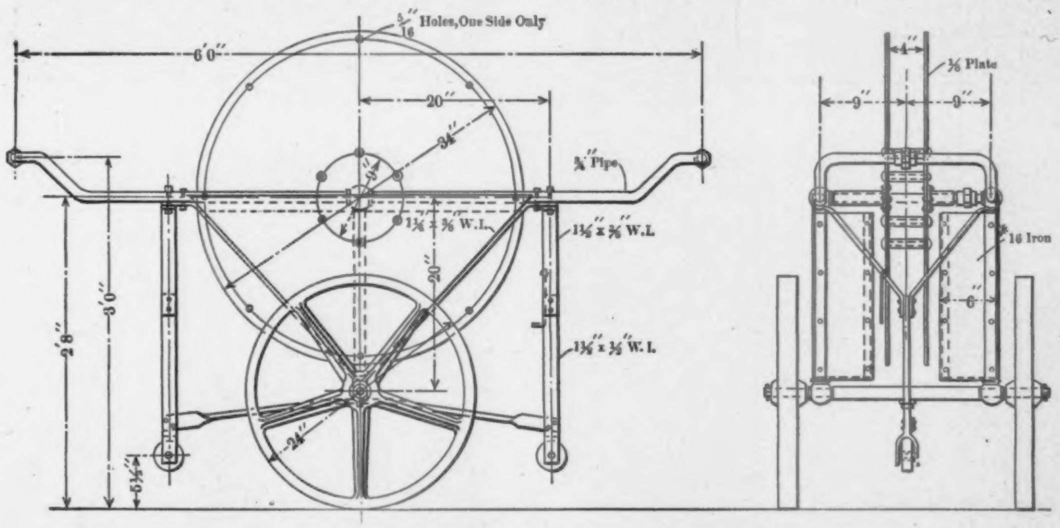
Truck for Boiler Washing Hose and the Boiler Washer's Tools.—This truck, or cart, is comparatively light and may easily be pushed about the house. There is no excuse for the boiler washer losing or misplacing his tools, or not keeping them in an orderly manner. The use of the hose reel has increased the life of the hose about 50 per cent. Where a hose reel is not used the hose is worn out by being dragged over rough floors and often it is left lying on the floor where it may be struck by falling objects or run over by trucks, wheelbarrows, etc. The side plates of the reel are of 1/8 in. steel and are spaced 4 in. apart, or just a trifle more than the diameter of the hose, thus preventing any possibility of its becoming tangled in winding it on or off the reel. The V shaped pockets on either side of the reel are for the boiler washer's tools and are 6 in. wide, about 19 in. deep, and 36 in. long at the top. They are made from No. 16 iron and are reinforced by iron bands or bars at the edges, as shown. The wheels are 24 in. in diameter and the push handles are of 3/4 in. gas pipe. The iron pipe nozzles used for washing out are shown projecting from the rear pocket in the photograph.

Portable Steel Tool Boxes.—Portable tool boxes for roundhouse machinists are not uncommon, but they are usually constructed of wood. While the steel boxes are more expensive than the wooden ones, as far as the first cost is concerned, they are practically indestructible and cannot be broken open.

These boxes are designed to hold all of the hand tools used by the workmen, except the larger wrenches, jacks, etc., which are kept in the tool room. This cuts out the necessity of a man making several trips for files, liners, chisels, etc., between the engine upon which he is working and his bench, which may be at opposite sides of the house.

The tool box shown in the photo is made of 1/16 in. steel with a wrought iron band 1¼ in. wide riveted along the top edges. The box is 39 in. long, 18 in. wide and 10½ in. deep. An end compartment, 12 in. wide, has a tray fitting in the top, which is about 7 in. long and may be moved back and forth, thus making it possible to get underneath it without lifting it out of the box. The cover of the box is flanged at the edges to fit over the sides and in addition is stiffened by the 1 x 1 in. angle, riveted to it. The truck is about 8 in. high.

Portable Vise Bench.—This bench may be moved near the engine, thereby saving the time usually consumed in carrying material back and forth between the engine and the wall bench. When used in connection with the portable tool boxes there is no need for maintaining the old style benches, which are usually a "catch-all" for an accumulation of wrenches, sledges, liners, bars, old overalls and all sorts of material. The men will not accumulate this stuff when they have to carry it from one engine to another in the portable tool box. These benches are 48 x 24 in. in size and 32 in. high. They are fitted with 6 in. vises. The timbers in the frame work are 2½ x 2½ in. and are bolted together by the 3/8 in. rods. The wheels are 8 in. in diameter.



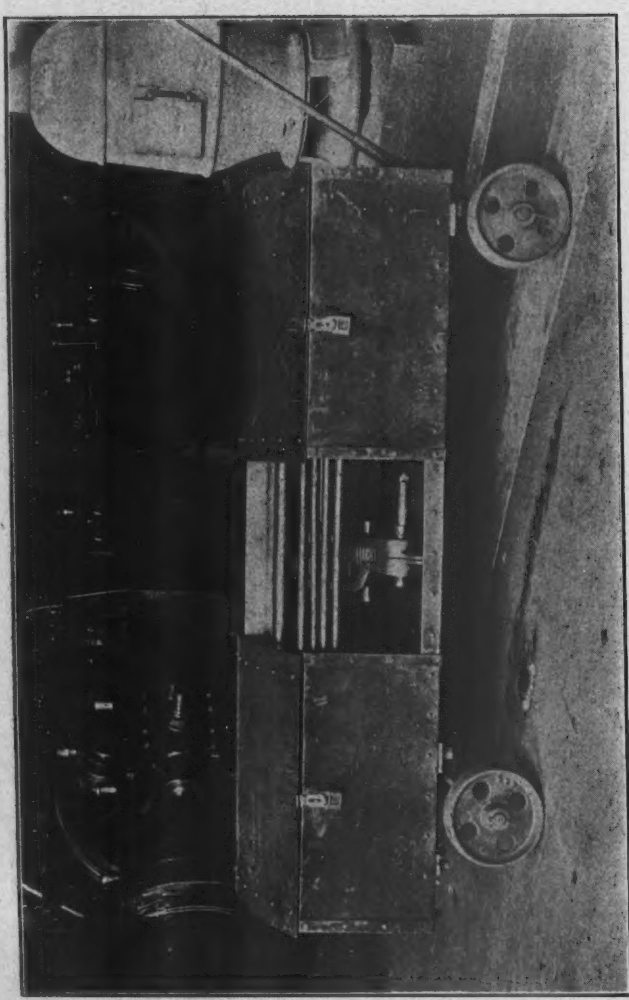
TRUCK FOR BOILER WASHING HOSE AND TOOLS.

Device for Pulling Down Binders.—This is used where the binders do not come down easily after the binder bolts are removed. The two yokes are slipped over the binder and connected to the rest of the apparatus, as shown, using wooden blocks between the ends of the long bar and the bottom of the pedestals. By operating the screw the binder is easily forced downward. The long bar is 26 x 3 x 1½ in.; the short one is 14 x 3 x 2½ in.; the screw is 2 in. in diameter and 10 in. long, with square threads.

Repairing Sand Boxes.—It is quite often necessary to repair the sand boxes, or the sanding apparatus, in the roundhouse. Even if the hostler understands that this is to be done and does not take sand before bringing the engine into the house there is usually more or less left in the box from the previous trip. This must either be emptied and wheeled to the sand house or dumped with the refuse. When the engine is ready to go on the road it must be stopped at the sand house on the way out to take sand, which in most instances is not a convenient operation. To overcome this difficulty the tank and the apparatus shown in the

BOX FOR VALVE SETTING APPARATUS—OPEN.

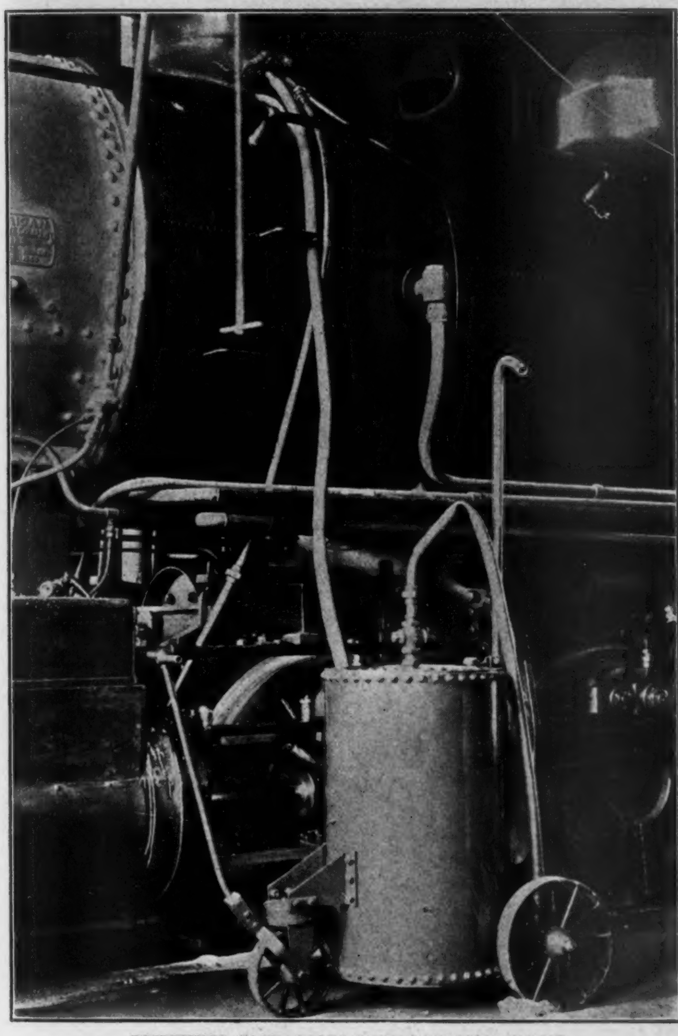
DEVICE FOR STRAIGHTENING BRAKE LEVERS, ECCENTRIC BLADES, ETC.



PORTABLE BOX FOR VALVE SETTING APPARATUS.

VALVE SETTING MACHINE.

photos have been constructed. If it is necessary to empty the sand box the tank is wheeled alongside the engine. The sand pipe is disconnected and the sand is run from the sand box on the locomotive into the tank through the rubber hose, as shown in the illustration below. The rubber hose is then disconnected and a nipple with a ¾ in. cut-out cock is screwed into the hole in the tank through which the rubber hose emptied the sand.



EMPTYING SAND FROM SAND BOX INTO TANK.

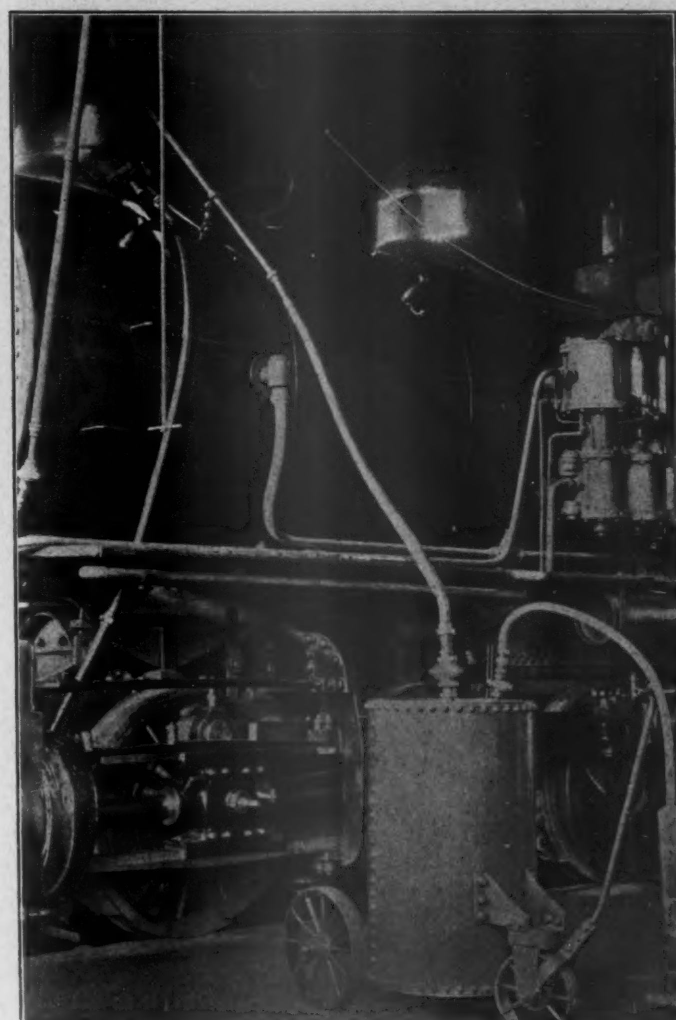
When the repairs have been completed the hose, which connects with a cast iron straight-way plug valve at the center of the head of the tank, is connected with the top of the sand box by means of a 1¼ in. pipe, which in the illustration above is shown standing alongside of the tank at the rear in an upright position. This pipe is securely held in place by a clamp, attached to the hand rail. A 1¼" pipe, connecting with the plug valve, extends to within about ¼ in. of the bottom of the tank. By connecting the ¾ in. cut-out cock with the compressed air line and allowing the air to enter the tank the sand may be quickly forced back up into the sand box.

The sand tank is 26 x 40 in. in size and of practically the same design as a main reservoir. A small amount of sand remains heaped around the side of the tank at the bottom, but this could be done away with by either shaping the bottom of the tank so that all the sand would run to the center, or by filling it with wooden blocking to give the inside the required shape. This apparatus permits the hostler to fill the sand boxes of all engines before they are taken into the house, whether repairs are to be made to the sand box or not, and it is thus never necessary to fill the sand boxes while the engine is leaving the roundhouse.

Valve Setting Apparatus.—Much time is lost, both in erecting shops and the roundhouses, in getting together the various parts of the device for turning the drivers and the necessary tools and trams used for adjusting and setting the valves. Parts of the apparatus are often lost or misplaced and oftentimes its condition generally is anything but what it should be. To overcome this a large portable double steel box has been constructed, specially arranged for holding all the apparatus and tools required for valve setting; it may easily be transported from place to place. It is kept in the tool room and when not in use is locked, as shown in one of the illustrations. Another view shows the box with the covers opened up and part of the tools removed. The box is constructed of ⅛ in. steel, reinforced at the corners by the iron bands, as shown. The wheels are 10 in. in diameter. The apparatus for turning the drivers is shown assembled in one of the illustrations and is driven by an air motor, the driving mechanism being modeled after that of an old cylinder boring machine.

Portable Hoist for Handling the Large Compound Air Pumps.—Many of our readers are familiar with the smaller size Franklin portable cranes and hoists. The one shown in the illustration is a special size and is used principally for handling the new Westinghouse 8½ in. compound air pumps. It is 12 ft. 9 in. high and the height of the hoist is 11 ft. 8 in. The bed is 4 ft. 10½ in. wide outside and 5 ft. 1 in. in length. The crane has an overhang of 4 ft. 1 in. and a capacity of 3 tons. It weighs about 1,940 lbs. and is manufactured by The Franklin Portable Crane & Hoist Co., Franklin, Pa. The two smaller castors at the side were added to increase its stability, thus giving it five points of support.

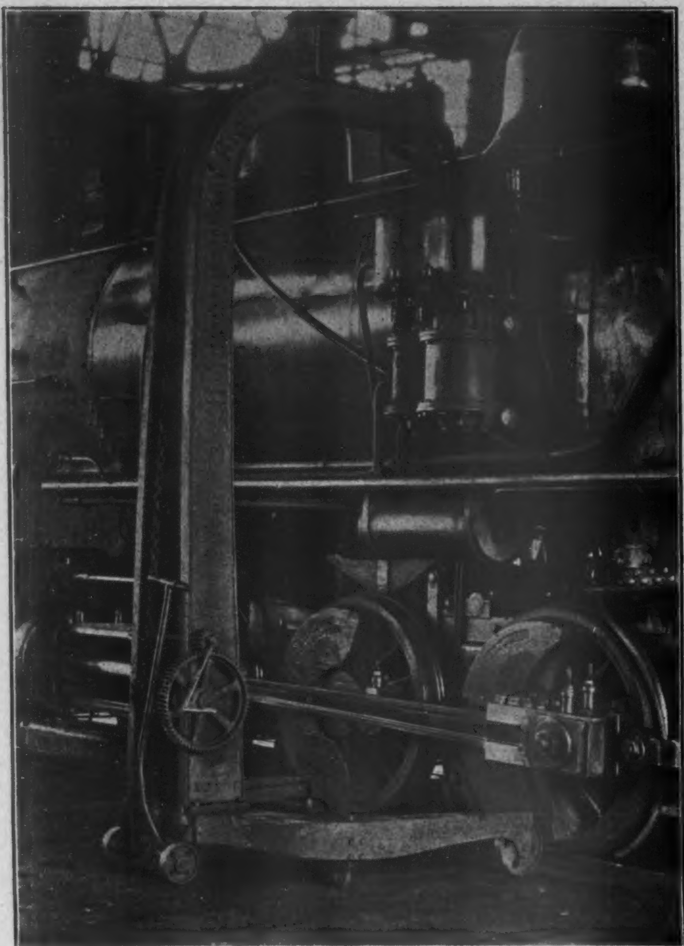
Device for Straightening Levers, etc.—This device is very simple and was designed for taking out kinks or bending brake levers or eccentric blades without taking them down. The strap



FORCING SAND BACK INTO THE SAND BOX.

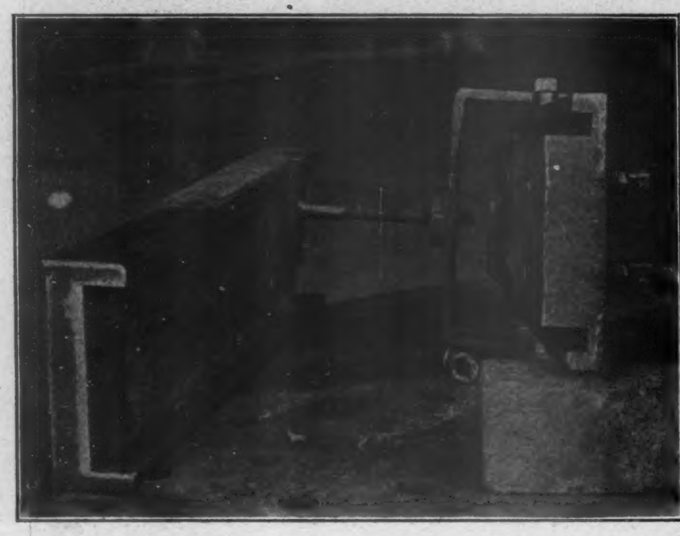
is placed over the lever or bar, which is to be straightened, and the key is dropped in place, as shown at the rear. By turning the screw bolt the lever may be bent the desired amount. A smaller one of these is used for the eccentric blades.

Gasket Cutter.—Considerable time is wasted in many roundhouses by cutting gaskets out with a knife; usually they do not give very good satisfaction when made in this way. A most

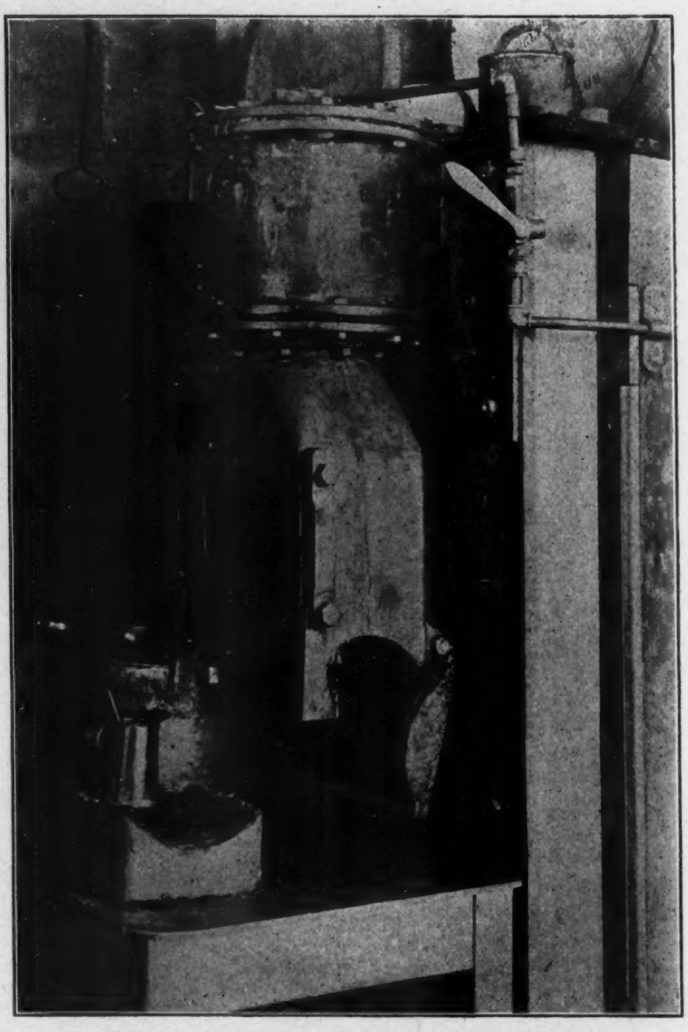


PORTABLE HOIST FOR HANDLING COMPOUND AIR PUMPS.

PNEUMATIC GASKET CUTTER.



DEVICE FOR BABBITTING CROSSHEAD SHOES.



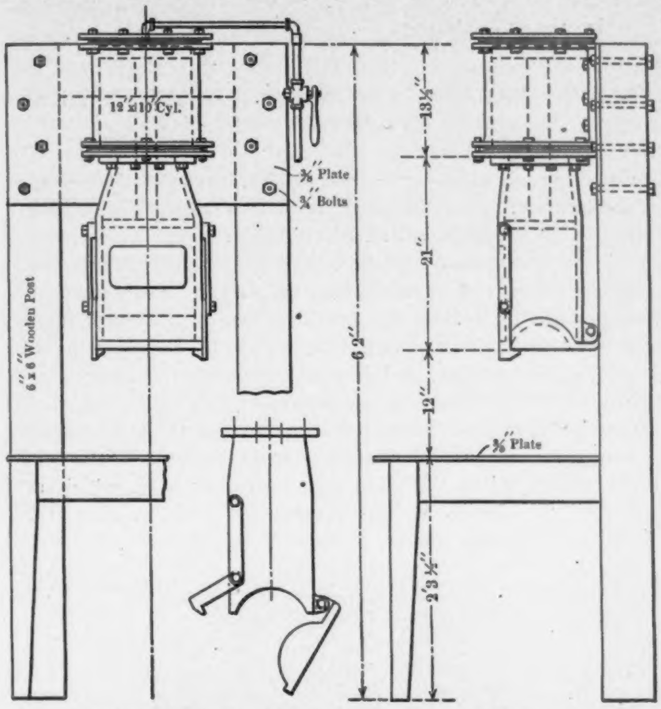
DEVICE FOR MOULDING GREASE FOR DRIVING BOX CELLARS.

efficient machine for cutting out gaskets from old hose has been constructed and is operated by the roundhouse tool man in his spare time. The air cylinder is 12 x 14 in. and is limited to a 3½ in. stroke, so that a comparatively small amount of air is consumed. The cutters are made of tool steel, as shown, and a copper plate is fastened to the top cross-bar back of the gasket, to reduce the liability of injuring them. The bar, which passes through a slot in the piston rod, limits its stroke and forces two pins upward, as the cutter drops back to the position shown in the illustration, pressing the gasket out. Where cutters of this type are struck with a hammer or sledge in cutting gaskets they are easily broken on account of the unequal pressure on the cutting edges. With this press there has thus far been no breakage and the life of the cutter seems to be indefinite.

Moulding Grease for Driving Boxes.—The device used for

moulding the grease for driving box cellars is illustrated both by a photo and a sketch. The bottom of the mould is held in place by the two latches and the grease is put in through the hole at the front. Air is then allowed to enter the 12 x 12 in. cylinder and the plate at the end of the piston rod presses the grease to the shape shown in the illustration. The former method of pounding the grease into shape by hand was slow and expensive.

Babbitting Crosshead Shoes.—The old practice was to fill the shoes with babbitt, over blocks slightly smaller than the guide, and plane them out to size. With the device illustrated the shoe,



DEVICE FOR MOULDING GREASE FOR DRIVING BOX CELLARS.

after being removed from the crosshead, is put in a frame; the frame is placed vertically on the floor and the babbitt is poured. The shoe is then ready to be replaced on the engine. No machine work is required and the entire operation may be performed in from fifteen to twenty minutes.

With the old method it was necessary, at roundhouses where there were no planers, to replace the shoe with one which had already been babbitted and was carried in stock. These shoes almost invariably required some fitting of the bolts, as the holes would not line up properly, so that in a short time a lot of shoes would accumulate in which the holes did not match properly with those in the crosshead.

THE AMERICAN RAILROAD EMPLOYEES' AND INVESTORS' ASSOCIATION.

The following letter has been issued by P. H. Morrissey, president, explaining the plans of the above association for benefit to all railroad employees and investors. This movement is deserving of the support of all our readers:

To Railway Men:

The American Railroad Employees' and Investors' Association, organized at Chicago, Ill., September 14, 1908, invites the railway employees of the United States to a serious consideration of its plans and purposes.

Necessity for a medium through which the railroads and their employees might act jointly on questions of mutual interest prompted the formation of the association. It aims to bring together the railway employees and railway owners for the purpose of cultivating and maintaining between them such concern on the part of all for the welfare and prosperity of American railroads as will best promote their successful and profitable operation for the benefit alike of the employees, the investors and the public.

The association will at no time be used for partisan political purposes and will take no part in controversies, if any, which may arise between railroad employees and railroad officials. It will encourage by every proper method cordial and friendly feeling on the part of the public toward American railroads and their welfare, and will oppose the enactment of untimely, needless or arbitrary laws in regulation or restriction of railroad business.

This movement is but the development of a sentiment often expressed by both employer and employee—that there is a mutuality of interests between the two. Co-operation is, therefore, natural and practical, for in no other way can the things in which they are commonly interested be protected. The last year and a half, with its thousands of railway men either out of employment or working on short time, with their lean pay checks, is an object lesson.

How long can the railroads stand against increasing cost of service combined with decreasing rate of compensation?

Our plan will be to enroll as members the large army of railway employees of the United States. They are sufficiently numerous to influence public opinion materially, to the end that the hostile attitude of opposing interests may be changed, and that railways may be operated profitably, thus furnishing continuous employment at good wages to the many engaged in the service. In order that its work may be carried on systematically, subordinate branches will be organized at points where the required number of employees work. State organizations will also be formed.

It should be distinctly understood that the association will not interfere in any way with any of the established organizations of railway employees nor will it attempt to assume jurisdiction over matters which properly belong to them. It is organized for a specific purpose and will keep within its legitimate bounds. Its methods will bear scrutiny, for it is open and above board.

Its executive committee is composed of an equal number of representatives of investors and railway employees, and as all are tried and reputable men, it is assured that the influences of the association will at no time be used for any purpose that will be antagonistic to the employees. The employee's connection with it will be from the standpoint of promotion of his material welfare and not subserviency to the wish of the employer. A small admission fee will be charged.

The association has come to stay. The active co-operation of the railway employees of the country will make its influence a power for good.

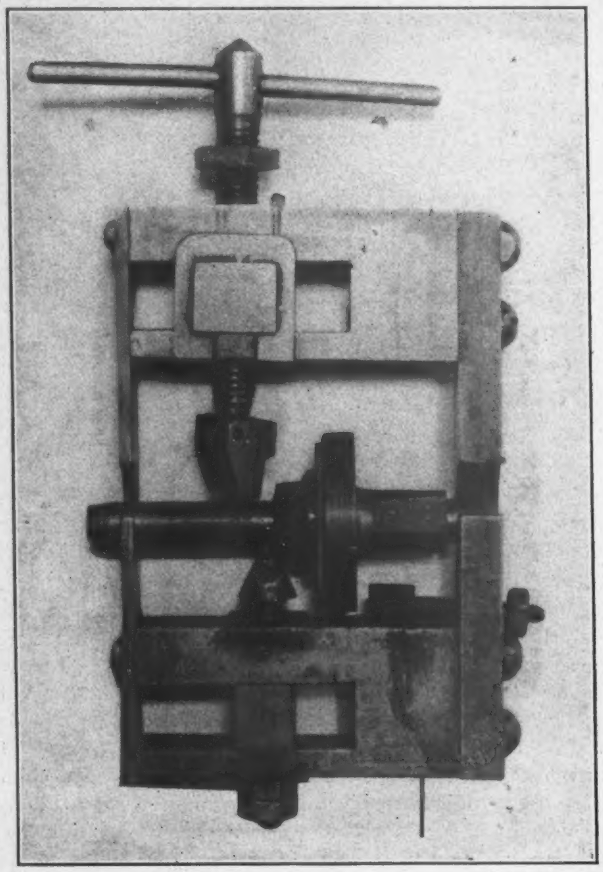
Mr. C. D. Kellogg, of Cedar Rapids, Iowa, formerly editor of *The Railway Conductor,* has been elected secretary, and to him all communications should be addressed at 233 Railway Exchange, Chicago. The by-laws of the association have been adopted and, with other literature and information, may be had upon application.

DEPRECIATION OF A POWER PLANT.—Charles T. Main, a well-known mill engineer of Boston, states that with good water and good care a stationary boiler should last about twenty years, thus having a depreciation of about 5 per cent. per year, assuming that it is operated 12 hours a day. Slow speed engines running 10 hours a day should have a life of about 25 years, or a depreciation of four per cent. High speed engines should have a depreciation of 7 per cent. or greater if operated more than 10 hours a day. Economizers have a depreciation varying from 10 to 2½ per cent., depending upon the initial temperature of the entering water.

AMERICAN SOCIETY OF HUNGARIAN ENGINEERS & ARCHITECTS.—A society having the the above title, has recently been organized for the purpose of bringing in closer touch the engineers and architects of Hungarian extraction living in this country and to give moral support and information to newcomers. It also desires to encourage the exchange of engineering, technical and industrial information between the technical men of Hungary and the U. S. and will hold monthly meetings. Information can be obtained by addressing the secretary at Box 103, General P. O., New York City.

REPAIRING TRIPLE VALVES.

The illustration shows a simple but ingenious device for finding whether the emergency valve stem of the triple valve is bent, or if the valve has been distorted. It is used in the air brake room of the west-bound freight car repair yard of the Pennsylvania Railroad at Altoona. The valve is slipped into place, as



shown, and the partially cone-shaped piece just below the valve stem is screwed to within a very short distance of the stem. By revolving the valve it can readily be seen whether the stem is out of true. The cone-shaped part may be slipped sidewise to test the stem at various points. If the stem is out of true it may be pressed back into place by forcing the screw above the valve stem downward.

To the right, but indistinctly shown, is another screw with a block at its left end; this may be brought to within a very short distance of the side of the valve. By revolving the valve it may be seen whether it is distorted, if so it may be taken out and repaired in a vise. This device was made by W. L. Goodman of the air brake department.

SHOULD RAILROADS MANUFACTURE?

In a *house organ*, published by The Crane Co., of Chicago, R. T. Crane writes an article on "Should Railroads Manufacture?" The article begins by saying:

"A nice question may be raised as to when a railroad legitimately and advantageously may enter into manufacturing for itself."

The writer relates how in his early business career as a manufacturer of car axle brasses he was asked to advise with the directors of the Galena (now the Chicago and Northwestern) railroad, as to whether they should go into the manufacture of their own brasses. Mr. Crane advised against it, and related how a few years ago Dr. Williams, of the Baldwin Locomotive Works, then a director on the Galena road, congratulated Mr. Crane on the wisdom of his counsel.

Mr. Crane continues: "After a long and varied business experience, I am more than ever of the opinion that the less manufacturing the railroads do the better. Railroad men, no matter how efficient, cannot be expected to know the inside and outside, the hindside and foreside of manufacturing, as well as those who devote their entire time to manufacturing."

It will occur to very many who read Mr. Crane's article to inquire where "a nice question may be raised as to when a manufacturer legitimately and advantageously may enter into publishing for himself, and whether a manufacturer, "no matter how efficient, can be expected to know the inside and outside, the hindside and foreside of publishing," as well as those who devote their entire time to publishing?—*Selling Magazine.*

PREPARING PACKING LEATHERS FOR AIR BRAKE CYLINDERS.

The photograph shows a simple device, used by the Pennsylvania Railroad, at its different shops, for forming the packing leathers for air brake cylinders. An 8 and a 10 in. cylinder are mounted in a frame work, as shown. The top part of the cylinders are counter-bored for a distance of about 1 in., so that the flat piece of packing leather fits into them nicely. A wooden block with a projection on its under side, which fits into the inner circle of the leather ring, and is concentric with the outer edge of the block, is placed on top of the leather ring; this is forced down into the cylinder by means of the screw press. The wooden block is just enough smaller than the inside diameter of the cylinder to accommodate the edge of the leather ring, which is turned upward. The screw is then raised and another ring and block are forced down upon the top of the first one.

In this way the cylinder is filled with a number of packing rings and blocks. Each time a packing ring is required for use and is about to be forced out at the bottom of the cylinder a new ring and block are put in at the top. The rings are not removed until shortly before they are placed in the brake cylinders. It will be seen that two rings have been placed in position, preparatory to being forced into the cylinder at the right, and a ring and one of the blocks have been forced out at the bottom.

SUPPLY OF WOOD.—The estimated amount of wood annually consumed in the United States at present is twenty-three billion cubic feet, while the growth of the forest is only seven billion feet. More than three times as much wood is thus being used than the forests are producing.

CIRCULATION IN THE JACOBS-SHUPERT FIREBOX

To THE EDITOR:—

In your editorial in the March issue you invite opinions in regard to the Jacobs-Shupert locomotive firebox, and I venture to give you the following;

I think the principal defect in this boiler will be the lack of longitudinal water circulation and of the direct scrubbing action which is necessary to remove the steam film from the hot sheet and replace it with solid water, thus preventing the overheating of the sheet and at the same time insuring efficient transmission of heat through the sheet to the water. The illustration in the first column on page 108 shows the provision made for the horizontal circulation of water from the barrel of the boiler to the back of the firebox, and it will be seen that the plate area in the partitions is larger than the open space area for water circulation, and this plate area will act as a baffle constantly impeding the water current where it should be as free as possible. The small area of the open space is particularly noticeable along the side sheets. The ribs which extend out from the normal surface of the side sheet will each act as a dam to all currents running along the length of the firebox, and instead of flowing freely along the side sheet and constantly scouring it, the current will move in a corrugated or sinuous line and it will tend to leave steam pockets at each channel flange. The current will thus be very slow in getting to the back of the firebox, which may be overheated. On page 110 the description says that it is of great importance to have a design that does not interfere with water circulation in order to transmit heat, but the impression given by this design is that it must interfere with the circulation, and this will be found to be its greatest defect.

In the crown sheet the V-shaped pockets on the fire side will allow clinkers to accumulate because they are not in the direct line of the flame current tending to clean them, and to the extent that these pockets are filled up, the heating surface will be reduced. The scale will form along the rivets on the opposite side just as it is illustrated on the crown bars in the old construction shown on top of page 108. There will then be a greater tendency for these sheets to overheat and burn out than in a radial stay crown sheet which is perfectly clear on the fire side and has only staybolt obstructions on the water side.

Referring to Fig. 3, page 107, it is difficult to understand how the mud ring can be fitted to such a firebox and be so tight as to prevent constant leakage, as the spaces are all slightly different in their curvature, and it is not clear how any effective caulking can be done. Advantage is claimed for thinner sheets, but within the limits of thickness ordinarily used for firebox sheets, there is no perceptible change in the rate of heat transmission, and modern formulas do not take account of the thickness of the sheet. The first cost of the boiler will be greater, the cost of maintenance higher, the life shorter and the consumption of fuel per unit of work not very different from present construction.

From what I have said above and judging from the construction as shown by your illustrations I should not expect the firebox of this boiler to last a year. If it does and proves to be an important improvement in locomotive boiler construction, I shall be much pleased and quite willing to admit that I have been mistaken in the opinions as above expressed. CIRCULATION.

To THE EDITOR:—

It is not surprising that the editorial in the March issue of your valuable journal, inviting comments on the Jacobs-Shupert firebox,* has called forth an adverse criticism from "Circulation." Human nature is naturally opposed to innovations, and the design of this firebox is a very decided innovation in locomotive boiler practice. Every innovation since time immemorial has met with opposition, and often with resentment. Everyone is familiar with the story of "Fulton's folly," yet steamboats are in operation to-day and there is no question as to their success.

Criticisms as to circulation and construction of this firebox are by no means original, for a number of competent mechanical men offered similar objections to the principles involved in the early design of this firebox when models were exhibited for the purpose of inducing comments. The work of developing this firebox has been progressing for several years, and many of its practical features are due to honest criticism, generously given. Several details have been contemplated and abandoned, and some of the original ideas have been greatly modified. In spite of the criticisms offered during the early stages of development, all practical men who have seen the actual boilers under construction at the Topeka shops have expressed unqualified belief in their ultimate success.

Your correspondent's principal objection to a boiler equipped with a Jacobs-Shupert firebox is what he refers to as the lack of longitudinal water circulation. While horizontal circulation is necessary to replace that water which has been generated into steam the greatest circulation around any firebox is vertical. When water in contact with the hot metal of the firebox becomes heated sufficiently to lessen its density, it rises and establishes convection currents. The circulation due to heat and convection currents causes the water in the boiler to rise vertically. Water replacing the heated water circulates in a direction depending upon the source of water supply. In the ordinary type of firebox, convection currents will be vertical at and near the inner side sheets. Water replacing the heated water will circulate horizontally as well as in an upward direction. In ordinary operation these currents will constantly intermingle. Much better results would be obtained if it were practicable to apply a circulating sheet separating the upward and downward vertical currents, thereby maintaining constant and uninterrupted convection currents. It would also be desirable, if possible, to separate the convection currents and the constant supply currents, thereby obviating any interruption in the vertical circulation. In no form of locomotive firebox, however, is the horizontal current of sufficient strength to give a scouring action along the side sheet, and this results only from the vertical currents formed by the rapid rise of the heated water.

The flanges of the channels forming the sides of the Jacobs-Shupert firebox, instead of impeding circulation, really assist it. These flanges tend to separate the vertical from the horizontal currents and thereby provide an unobstructed path for the upward movement of steam bubbles leaving the heated metal. The supply currents are prevented from distorting the convection currents and when the two become mingled, the general tendency in direction will be upward along the side of the firebox.

The experiments made by the Northern Railroad of France some years ago, demonstrating the relative value of heating surface in locomotive boilers, are well known. By dividing the boiler into separate sections and measuring the water evaporated in each section, the effectiveness of heating surface was found as follows:

Sections 1, 2, 3 and 4 are of the tubes, and section 5 is the firebox.

Sections.	1	2	3	4	5
Area, square feet	179.2	179.2	179.2	179.2	76.8
Evaporation, lbs. per sq. ft.	2.0	2.9	4.3	9.7	34.7
Evaporation, % of total	5.5	8.6	12.7	28.7	44.5

Upon entering the boiler and moving toward the firebox the quantity of water passing through any section is less than that through a previous section by the amount evaporated during its passage. In the case cited, only 44.5 per cent. of the water passed to the firebox, the other 55.5 per cent. being evaporated before it reached the firebox. This is an important consideration in determining the sizes of the openings leading from the barrel of the boiler to the water legs.

Thirty thousand pounds of water are used per hour by a locomotive of the type to which the Jacobs-Shupert is applied, when working at the maximum capacity possible for it to maintain for any length of time. The area through the check valve is 2.36 sq. ins. and the velocity of water through the check valve is 81 feet per second, assuming that one injector delivers all the water and operates continuously.

In order to show the size of the water spaces leading from the barrel of the boiler to the water legs of the Jacobs-Shupert firebox, the accompanying illustration (Fig. 1) of the firebox

* For detailed description see page 106, March issue of this journal.

under construction is presented. The area of the space through the stay sheet immediately adjacent to the mud ring is 16.94 sq. ins. on each side. The area of both spaces then is 33.88 sq. ins. If half of the water is evaporated before reaching the firebox, and all water going to the water legs passes through the spaces immediately over the mud ring, the velocity of the water as it enters the water leg will be only 2.4 feet per second This velocity will never be exceeded and will really be much less, due to the fact that a considerable portion of the water will pass through the openings higher up in the stay sheets.

The criticism that the V-shaped pocket on the fire side of the crown sheet will allow "clinkers" to accumulate, is probably intended to mean the accumulation of so-called "honey-comb" sometimes noticeable in fireboxes. It is generally recognized that such an accumulation does not occur except where there is a leak. There is no reason, then, why this material should collect at any of the joints of the channel sections, or in the "V-shaped pockets" mentioned by "Circulation."

Experience with fireboxes having submerged seams at the juncture of all sheets illustrates quite clearly what may be expected as to any accumulation at the joints. The construction of the submerged seams produces a formation similar to that at the joint between the channel sections of the Jacobs-Shupert firebox. Fireboxes having these submerged seams have been in service for five years and during that time there has been no evidence of leaks or of any accumulation in the pockets at the joints.

Referring to Fig. 6, page 108, of the March issue, the criticism is made that scale will form along the rivets on the water side of the section corresponding to the crown sheet. There can be no comparison between the obstruction offered by a row of cone head rivets and the T irons of the sling stays. It is customary practice to introduce several rows of sling stays at the forward end of a crown sheet supported by radial stays. The usual form of T irons used in connection with sling stays impedes circulation to such an extent that it is not uncommon to find the space beneath the T irons solid with scale. This collection of mud and scale has caused crown sheets to burn even with water in the boiler at proper level.

The criticism as to the practical application of the mud ring is most readily answered by referring to the accompanying illustration (Fig. 2) of the interior of the firebox showing the mud ring in place, and to the sketch (Fig. 3) showing the method of reverse lapping the sections to fit the mud ring.

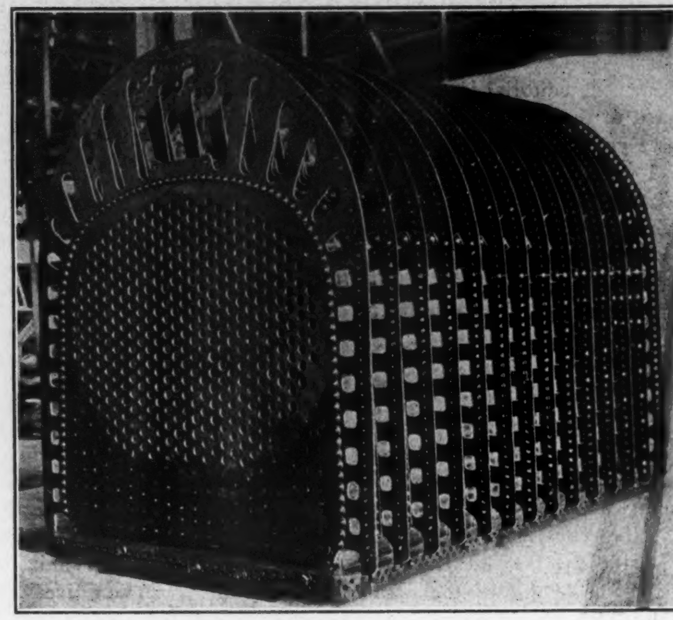


FIG. 1.—JACOBS-SHUPERT FIREBOX UNDER CONSTRUCTION.

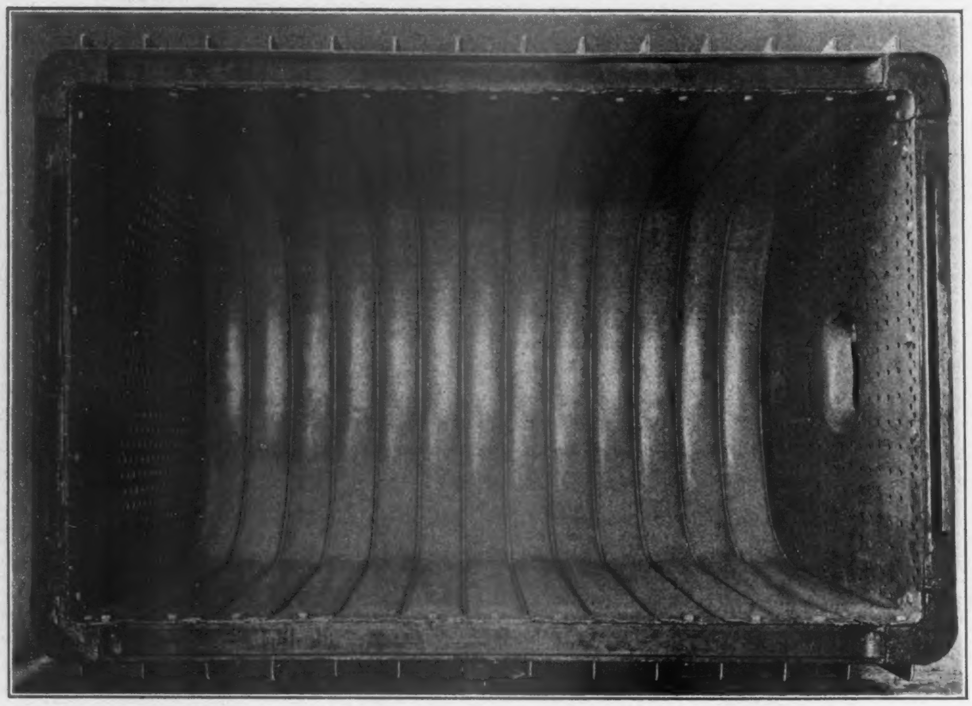


FIG. 2.—VIEW OF INTERIOR OF JACOBS-SHUPERT FIREBOX, SHOWING CONNECTION TO THE MUD RING.

The criticism that the thickness of the sheet does not enter into consideration in the design and construction of boilers, is hardly in accord with the most eminent authorities. In all formulæ for the rate of conduction of heat, the thickness of the plate is taken as the denominator of the fraction, and the various authorities agree that conductivity is inversely proportional to the thickness of the plate. For example, the formula by Professor Clerk Maxwell (Theory of Heat, page 234), is as follows:

$H = a\,b\,t\,k\,(T - S) \div c$, in which
c = thickness of plate.

In Rankine's formula:

$Q = (T^1 - T) \div r\,x$, in which
x = thickness of plate
and r = internal thermal resistance, constant for any one material.

In the "Modern Steam Boiler" by Rowan, the author quotes Mr. Blechynden as follows:

"The results of experiments certainly point to the conclusion that the thinner the plates forming part of the heating surface of a boiler, the higher should be the boiler's efficiency."

Topeka, Kan. H. W. JACOBS.

IDLE CARS.—The number of surplus cars on March 17 was 291,418, a decrease of 8,507 in two weeks.

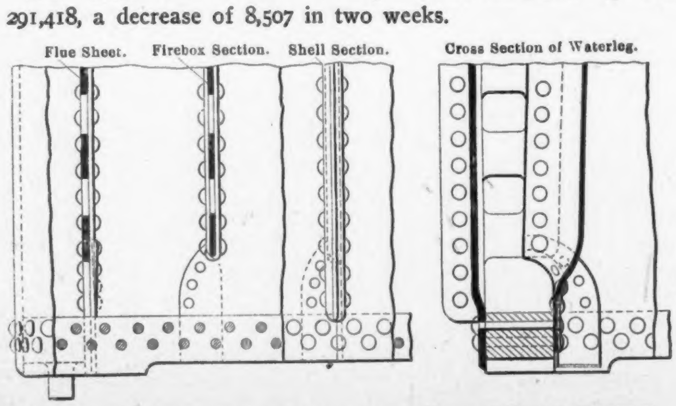


FIG. 3.—CONNECTION TO MUD RING—JACOBS-SHUPERT FIREBOX.

EFFECT OF FLAT WHEELS ON RAILS.

TO THE EDITOR:

The discussions of my article on the effect of flat spots* by E. L. Hancock, given in your March number, and by George L. Fowler, in the *Railway Age Gazette*, January 8, 1909 (reprinted in the next column), are, I consider, more due to a misunderstanding of the article than a valid criticism of it.

Mr. Fowler calls attention to the fact that a flat spot delivers a substantial blow at speeds above five miles an hour as antagonistic to the results arrived at, and suggests that both writers based their computations on gravity, from which I can only infer that Mr. Fowler did not read carefully either the conditions assumed or the results stated in my article. The conditions assumed are very largely those outlined by Mr. Fowler, but on account of the weight below the springs supported by the wheel being considered as dropping with the wheel the acceleration taken is ten times that of gravity in place of 17.7 times as taken by Mr. Fowler. The speed at which the flat spot strikes its maximum blow would not, however, vary directly as the acceleration, but as its square root as shown in Section 1 of Mr. Spilsbury's analysis,† while if the decreasing action of the spring is taken into account it would be somewhat less. As a matter of fact for any ordinary flat spot the actual drop of the wheel is so small that the action of the spring may, without introducing any appreciable error, be taken as constant.

With regard to practical considerations of the irregularities in track, rolling of car, etc., it is true that these enter into the question and cannot easily be allowed for, but as I understand the importance of this question, the information desired is the order of magnitude of the blow delivered by flat spots with the existing limitations, and I consider that the results arrived at in Mr. Spilsbury's analysis have determined this to be of a reasonable and safe amount as opposed to the highly dangerous magnitudes arrived at in Mr. Hancock's original calculation. The blow will be substantially increased or decreased in the same way as the pressure between the rail and a wheel without a flat spot varies from the same causes, but this does not lead us to neglect the weight on the wheel as a measure of the pressure on the rail, and I consider that the kinetic effect of the wheel striking the rail is determined by Mr. Spilsbury with the same accuracy, with the proper figures for the various quantities, that the pressure between the wheel and the rail is, when the weight on the wheel is known, provided of course that no actual error is shown in the calculation, which so far has not been the case.

I do not quite understand Mr. Hancock's position, wherein he states that it is more rational to consider only the mass of the rotating parts as concentrated at the center of the wheel, as to whether he intends to supplement this with the action of the springs. If this be the case he has abandoned his original condition and there is simply a change in the assumptions I have made, and as an extreme condition let us take the weight of the wheel and one-half the axle as the rotating weight, say 1,100 pounds, take the same total weight per wheel as before, and assume that the springs, carrying the entire remaining weight per wheel, press directly on the journal. The resulting maximum striking velocity (see result D) is 4.6 ft. per second in place of 3.8. In other words, there is weight of 1,100 pounds striking at 4.6 ft. per second against one of 1,600 pounds at 3.8 feet per second, as originally assumed. The kinetic energy is 363 foot-pounds against 358 in the latter.

There is no assumption of an upward force in Mr. Spilsbury's analysis; when a body of mass M is rotating around a center, distance R from its center of gravity, the centrifugal force, as it is generally termed, is $Mv^2 \div R$, and this is the force referred to when the condition is postulated as in Section 1 of the wheel turning around the leading edge of the flat spot.

I trust you will pardon these demands on your space, but I consider Mr. Spilsbury has supplied a correct and reasonable analysis of this important question and one that agrees with practical experience, and I feel that the discussions that have taken place would not leave an entirely correct impression.

Montreal, Can. H. H. VAUGHAN.

* AMERICAN ENGINEER AND RAILROAD JOURNAL, December, 1908, page 475.

† Page 477, December, 1908, issue.

(*Abstract of Communication from Geo. L. Fowler in the Railroad Age Gazette, January 8, 1909.*)

Every practical railway man knows that a flat spot does deliver a very substantial blow at speeds above five miles an hour if the evidence of the sense of hearing and an occasional bent rail is of any value. So it seems that there must be something wrong, not necessarily with the mathematics but with the premises on which the calculations are based.

A suggestion is offered to the effect that both writers (Vaughan & Hancock) based their computations on gravity, as if this were the only thing to be taken into consideration, but there are others.

For example, the weight of the car is resting on the axle box through the intervention of a spring, and this spring is, therefore, under considerable compression and ready to expand with all the strength of its elasticity the moment it gets a chance. The axle is being drawn by its housing and the truck pedestal, in which there is considerable lost motion, and so is crowding back against the fixed parts of the truck, and there is always a possibility of its being thrown forward to the limit of the lost motion by any force tending to drive it to the front. So when the wheel starts to roll over the flat spot there is the quick acting spring tending to push it down and forward. This spring has a compression due to the load above, which may be 18,000 or 19,000 lbs. Taking the lower figure and considering the wheel and half the axle to weigh 1,075 lbs., the rate of acceleration during the fall of the wheel will be about 17.7 times as fast as when gravity alone is at work. This would immediately raise the speed at which the train can be running, and the flat spot strike its full blow, from 4.55 to something more than 79.5 miles an hour, modified by the decreasing tension of the spring as the wheel drops away from it, by which the rate of acceleration is correspondingly decreased. The problem is further complicated by the size of the spring, as the fall in spring pressure will be the more rapid as the stiffness of the spring and its consequent compression is increased, and the severity of the blow will be increased according to the downward velocity of the wheel at the moment of the impact of the flat place. Further complications are added, in practice, by the motion of the load at the moment. If the car body is rising in its vibrations the blow will be less than if it is falling.

It appears, then, that this spring action accounts for the fact that the severity of the blow apparently increases with the speed, because the spring has a chance to produce a rapid downward acceleration, and may account for the destructive effects produced both on track and rolling stock, while the complexity of the forces involved renders a mathematical analysis and solution of the problem no easy task and one that would not be conclusive when it was finished, simply because there would be no certainty that all of the factors in the case had been taken into consideration and given due importance.

THE MINE RESCUE STATION AT THE UNIVERSITY OF ILLINOIS.—The United States Geological Survey in coöperation with the State Geological Survey has established at the College of Engineering, University of Illinois, Urbana, Illinois, a Mine Explosion and Mine Rescue Station. The purpose of the station is to interest mine operators and inspectors in the economic value of such modern appliances as the oxygen helmets and resuscitation apparatus as adjuncts to the normal equipment of mines. The station also will concern itself with the training of mine bosses and others in the use of such apparatus. Its service is to be rendered gratuitously, and so far as possible to all in Illinois, Indiana, Michigan, West Kentucky, Iowa and Missouri, who may desire the benefits thereof.

The formal opening of the station constituted a part of the proceedings of a Fuel Conference which was held at the University of Illinois March 11 to 13, inclusive.